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Latest Pronouncement On Damage by Smelter Smoke

FEDERAL Judge T. D. JOHNSON recently handed down an opinion and interlocutory decree which later will be summarized at length in these columns in connection with a brief historical review of the smoke litigation in the Salt Lake Valley, Utah. It may not be amiss, however, now to point out the important findings of the court.

An interesting swing of opinion regarding the real nature of smoke damage may be noted. Thus, the so-called Godfrey decree, which caused the abandonment of more than one smelting plant in that region and the installation of efficient dust-catching devices in the others, accepted the idea that certain plant and animal injury was due largely to compounds of sulphur and arsenic which condensed on particles of soot or other solid matter and settled with them to the ground. In this latest decree, however, the Judge stipulates that the smelters shall so operate that the chimney gases shall be as free as possible of all solid matter "except unconsumed carbon." Evidently this is a recognition of the experimental demonstration that plant injury is caused by breathing dilute SO_2 gas into stomata or breathing pores of the foliage, there to be converted into sulphuric acid by the nascent oxygen and moisture accompanying reduction of CO_2 in these little cells.

On the basis, implied if not expressed, that smoke damage in the vicinity of modernly equipped smelters is due solely to unduly high concentrations of SO_2, the Court finds:

First: That there is no so-called "invisible injury" to vegetation; that plants to be injured by SO_2 must be definitely marked or bleached; and that the sulphur content of plants is not an index of injury due to SO_2.

Second: That there is no injury to screening or wire fences because of the action of such gases as come from the smelters at Midvale and Murray.

Third: That there is no injury to animal life because of the operation of these plants.

Fourth: That there is no injury to health, except that resulting from nervous excitation and fearsome worries of supersensitive inhabitants. As a matter of fact, this mental condition seems to be prevalent among many so-called "smoke farmers." No solution of the smoke problem would be satisfactory to them short of absolute elimination of any smell of smoke. As a matter of fact, the Judge remarks that this condition would probably effectively bar smoke damage upon plants, due to the extreme dispersion then existing; and is a consummation to be hoped for.

It may fairly be said that the Court takes too narrow a view as to the law in this regard. If his idea should be carried to the extreme, that there shall be absolutely no nuisance to any one because of the operation of an industry, then no industry could survive. Even the street cars could not run nor could railways operate because, surely, these utilities annoy some people. The "balancing of inconveniences" has not been taken into account, and if the Court's view were to prevail, then logically a single irritable person might close an industry from which thousands of people gain livelihood.

Dr. P. J. O'GARA, of the American Smelting & Refining Co., may be pardoned if he sets another feather in his cap as a result of this decision, for it is unquestionably his enthusiastic and able smoke investigation which has indicated the safe method of operation for the Murray plant, to mention but one. Both his company and the United States Smelting Co., co-defendants in the present case, have maintained experiment stations, and of their work the Court says: "The research work of these scientific men has been admirable, and it is unfortunate that the plaintiffs and other farmers of the community have not taken more interest in the experimental farms of the defendants and profited by the information acquired in the operation of said farms and the experiments made at these stations."

Twenty years ago we recognized that fume particles would cause damage in territory surrounding smelters, and in the intervening time we have discovered how to eliminate all solids, given the necessary incentive, by dust chamber, baghouse and electrical precipitator. Little progress, however, has been made in abating the sulphur nuisance. One could on occasion build a smelter in a desert region, but straightway transportation and labor troubles cost more than smoke damage. Purchasing easements or title outright to nearby farms is a very expensive and not altogether sure alternative, as more than one manager can attest. Consequently the idea advanced long ago that SO_2 must be dispersed through high central chimneys and properly diluted by air before reaching the growing plants still remains valid, fortunately upheld by precise experimentation undertaken during the past few years.

In fact, this remains the only practicable solution of the smoke problem now known. Various projects for neutralization have been suggested, and the production of elemental sulphur from SO_2 has been thoroughly investigated, but it is unlikely that these methods can be utilized. Sulphuric acid and liquid sulphur dioxide are now manufactured at several smelters, but few of them are situated so that a considerable outside market can be served. An internal market for sulphur as a metallurgical reagent sounds like an attractive possibility, but on sober second thought it is seen to be only a palliative—smelters already have too much of it in their systems and eventually it must be eliminated in some way or other as a non-offensive or useful solid, liquid or gas. That is exactly the problem which always must be met!

Standardization That Will Work

A MOST commendable step forward is being taken by the Association of Scientific Apparatus Manufacturers through the work of its Committee on Standardization of Apparatus. Apparatus catalogues filled with wonderful pictures and long lists of apparatus of every size and style and shape to suit any need or whim of the user are very impressive. But anyone who has undertaken to purchase from such a book has found it more of a disappointment than a real aid. It is most encouraging therefore to learn that the apparatus manufacturers are rapidly changing their practice so that they intend hereafter to list in their catalogues only the sizes and styles that they actually produce and regularly carry in stock or are on their shelves as purchases from other makers, domestic and foreign.

About one-half of the sizes of porcelain dishes or beakers will amply serve the need of any laboratory. In fact it is the practice of many to order either every alternate or every third size listed. Those who have ordered the even numbered sizes would be just as happy and just as well served with the odd numbers and vice versa. We, therefore, commend the tendency to eliminate some of these sizes that are merely listed, and actually to keep in stock ready for delivery everything that is described in the catalogue.

A standardization by all the manufacturers working together will have many other virtues besides making it possible to carry in stock all the listed equipment. It makes very little difference to the laboratory man whether a 400-c.c. flask is fitted by a number 5 or a number 7 rubber stopper, but he will appreciate it greatly if all makers will produce the same size flask with the same size neck so that when one is broken it may be replaced by another that may have been purchased from a different dealer without the necessity of using a different sized stopper in the apparatus. This interchangeability, though not vital, is of sufficient importance to justify considerable expenditure by the makers of glassware, whether blown or molded, to get together upon a common basis of size and style. Temporarily, the cost will be appreciable, but ultimately the gain to all parties concerned will far offset this temporary financial burden.

It is to be hoped that the Association of Apparatus Manufacturers and the American Chemical Society committees jointly will be able to make rapid progress to the ends which they have in mind. We would urge upon all purchasers of apparatus to extend to these committees their most cordial co-operation and support. Unnecessary difficulties need not be imposed because of individual whim or preference. You may be temporarily inconvenienced by having to change your practice as to size or style of apparatus, but ultimately you will greatly gain by the adoption of general specifications which all manufacturers and all users can strive together to maintain. When some of these ideals of standardization have been achieved, your purchasing problems will be greatly simplified; the bids you receive from different dealers will be comparable and will mean something to you; you can anticipate prompt deliveries of exactly what you order, and the cost of the product will ultimately be reduced because of the greater simplicity and lower expense of doing business upon a rational, practical basis.

Boiler Economy From Distilled Feed-Water

A CASUAL reader might wonder what place in the columns of CHEMICAL & METALLURGICAL ENGINEERING a subject would have so clearly understood to be in the field of mechanical engineering as steam generation and steam plant efficiency. Yet his doubts would be cleared if he remembered that a chemical engineer's problems are largely connected with the application of mechanical engineering to chemical and physical processes, such as the mixing and handling of materials of all sorts, their heating or refrigeration to various temperatures under various pressures, and the evaporation of large quantities of solutions, with or without the recovery of solvents. And by far the larger majority of his heating processes are conducted by means of steam. Yet chemical operations may commonly be observed proceeding with such an utter disregard of steam economy as to remind one of the ancient atmospheric engine which prompted JAMES WATT to invent the condenser.

Evaporating practice, it is true, has been perfected to the point where multiple effect operations are common, yet probably few chemical engineers have been prompted to suggest the same principles and much the same equipment for their boiler plant. Even at that they would only be utilizing a practice long standardized in steamship design.

All these reflections were suggested by hearing a recent address by PERCY H. THOMAS on the Chile Copper Co.'s large steam-electric plant at Tocopilla, Chile. Situated as it is on a desert coast, the amount of fresh water available was so limited that conditions actually were similar to those encountered by shipbuilders, and the same solution was arrived at, namely, running all prime movers in closed circuit with a condensing system, and making up by distilled water any deficiency due to leaks and imperfect condensation. At first blush, distilled water seems to be a rather expensive boiler feed, but actually it presents some important advantages both of convenience and cost.

At Tocopilla the main units are turbo-generators with the last stage under 28.5 to 29 in. vacuum. All the steam auxiliaries, however, work at normal pressure and exhaust into a single low-pressure evaporator shell, which in effect is quite similar to the surface condenser so familiar to power plant engineers. This condensed steam is then returned to the boilers as hot water, and its latent heat produces almost pound for pound the same amount of steam from the salt water surrounding the condenser tubes. Losses here are only those of radiation, which can be insulated to a minimum, and those due to a continuous wastage of a small amount of hot concentrated brine. Vapor from this hot brine is liquefied in turn by the condensate from the main exhaust, and even its latent heat is returned to the boilers. By such means a fresh supply of pure water is always available for a small additional amount of fuel, and the arrangement is such that no great complexity of unusual equipment must be looked after by the power-house employees.

The floating power plants in modern steamships have adopted the surface condenser more from lack of fresh water than from considerations of thermodynamic efficiency. Many land plants favor the jet condenser, usually because certain conditions of cooling water make it undesirable or too expensive to maintain surface condensers, and supply their boilers with a correspond-

ing stream of so-called fresh water, containing a variable amount of gases and solids in suspension and solution. Yet it has been remarked that turbine blades on shipboard were seldom if ever subjected to the destructive erosion so common in stationary plants and ordinarily ascribed to water mist, but really due to minute particles of solid matter. These minor advantages in the engines are of smaller interest to the chemical engineer than the economy in boiler practice which they reflect. Boilers run on distilled water evidently will be comparatively free from incrustations, with a correspondingly efficient heat transfer from the furnace gases to the hot water. Scale-free boilers are safer to operate and last considerably longer, and are capable of quickly assuming a heavy overload with small danger to the equipment.

All these advantages are as real to the boiler house attached to a chemical plant and furnishing steam mostly for evaporative or other heating use as it is for another boiler house generating steam for the hugest engines. Yet the economies are so substantial that a recent power house erected at Buffalo has been equipped for distilled make-up water, even in the neighborhood of such a tremendous reservoir of such excellent water as Lake Erie.

Rise and Fall of The Bessemer Rail

THE statistics of rail production in the United States in 1919, recently presented by the American Iron and Steel Institute, show in even more striking fashion than previous presentations have done the practical elimination of the bessemer rail. Only 214,121 tons of bessemer rails were produced, against 1,893,250 tons of open-hearth, showing a proportion of about nine to one in favor of the open-hearth. Only seven years earlier, in 1912, the proportion had been two to one for open-hearth, while in 1910 the bessemer had predominated, and in 1907 the proportion had been thirteen to one in favor of bessemer.

The nine to one proportion for open-hearth in 1919 was not all the story, however, for the proportion of bessemer in the various weights was as follows:

	Gross Tons, Total	Per Cent Bessemer
100 lb. and over	478,892	2.22
85-99 lb.	965,571	3.11
50-84 lb.	495,577	25.58
Under 50 lb.	263,803	17.72
Total	2,203,843	9.71

The percentages given above are those computed by the Institute, and are of the total output, but 96,422 tons of the total output was in re-rolled rails, so that the proportion of bessemer rails to total of new rails was somewhat larger than indicated. It is clear that the bessemer rail has been eliminated almost entirely for really heavy duty, i.e., for 85-pound rails and heavier.

The supplanting of the bessemer rail appears all the more remarkable when it is recalled that for nearly a quarter of a century the chief use of bessemer steel was for making rails. Captain ROBERT W. HUNT gives the Kelly Pneumatic Process Co. the honor of producing the first bessemer steel made in the United States. It was blown in a 2½-ton vessel at Wyandotte, Michigan, in the fall of 1864, working under American patents which post-dated BESSEMER'S. ALEXANDER L. HOLLEY and his associates were the first to bring the then new process to a commercial success, commencing operation of a 2½-ton vessel at Troy, N. Y., on Feb. 16, 1865, under the Bessemer patents which he had secured some time previous.

The first reported production of bessemer rails was in 1867, 2,277 tons. Ten years later, in 1877, the bessemer rail production, 385,865 tons, exceeded the iron rail production, 296,911 tons. The production of bessemer steel ingots and castings in 1877 was 500,524 tons, so that nearly all the rolling of bessemer steel was into rails. In 1887 there was 2,936,033 tons of bessemer ingots and castings and 2,101,904 tons of bessemer rails, while in 1890 there was 3,688,871 tons of ingots and castings to 1,867,837 tons of rails, but 1890 was the last year in which bessemer rails surpassed all other rolled forms of bessemer steel. The wire nail, a bessemer proposition, came out in 1886 to the extent of an estimated 600,000 kegs, the next year having an estimated production of 1,250,000 kegs. In 1886 it was shown, at the Riverside works at Wheeling, that welded pipe could be made of good quality with bessemer steel. Thus for two decades anyhow bessemer steel reigned supreme as the material one should use if he wanted to make rails. When the full production statistics for 1919 become available a close estimate can be made, but meanwhile the guess may be hazarded that in 1919, while 214,121 tons of bessemer steel rails was produced, about 5,000,000 tons of other finished steel products, bars, pipe, wire, sheets, tin plate, etc., was made of bessemer steel. Even though Mr. HOLLEY was regarded as the foremost apostle of the bessemer process, he once enthusiastically exclaimed: "I expect to live to see the American open-hearth process attend the funeral of the bessemer process!" He died too young, but apparently modern requirements are for better rail steel than can be made in a converter alone.

Only fifty tons of electric steel rails was made in 1919. In 1912 3,455 tons was made and in 1913, 2,436 tons, the two years making a high spot in the statistics for the electric rail. Final results of the experiment are presumably being awaited, but apart from that, it may readily be imagined that there has been neither energy nor money for experiments in the laying of additional electric rails. The matter may be taken up again under more favorable conditions.

Rail exports made a record in 1919 both in quantity, 652,449 tons, and in proportion of total output, approximately 30 per cent. The quantity left for domestic consumption was only 1,551,394 tons, which compares with the record made in 1906, 3,654,794 tons, as in that year there had been 3,977,887 tons production, 4,943 tons imports and 328,036 tons exports. It should not be assumed, however, as has so often been loosely stated, that the railroads were allowed to run down during the period of Government control. Renewals in 1919 were about 1,350,000 tons and in 1918 1,111,638 tons, this comparing with an average of 1,328,316 tons a year in the three years ended June 30, 1917, the period that had been selected as the "test period" in determining the amount of rental the Government should pay the railroad companies. Rail consumption last year was light chiefly because there was practically no new building either of road or of secondary track, and because there was no inordinate wear of rails, as there had been in the first few years of the present century through the introduction of much heavier rolling stock than the light sections then in track were able to carry efficiently.

Readers' Views and Comments

A Study of the Lime-Soda Ash Water Softening Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest the criticism by W. M. Taylor[1] of the analytical study of Herrle and Gleeson[2], on the lime-soda ash water softening process and find several points with which to take exception. Mr. Taylor's discussion of minimum hardness applies when an insufficient amount of soda ash is used as he recommends, but when a slight excess of it is used, as recommended by the authors, the solubility of the calcium and magnesium carbonates is decreased enormously in accordance with the solubility product law.

As to whether an insufficient or slight excess of soda ash is in accordance with best engineering practice depends absolutely on the way the boilers are run. Large amounts of salts must not be allowed to accumulate in the system, as they cause the vaporization to be irregular, due to variations in concentration set up by localized vaporization and mixing lag, with the result that the very dangerous phenomenon known as priming is effected. The plant engineer who adopts Mr. Taylor's recommendations will have to keep his boilers well blown to prevent scale, or if he prefers to follow the ideas of Messrs. Herrle and Gleeson, he will have to tap off sufficient boiler water to get rid of his salts and prevent priming conditions. Good practice of either method will get results which can be measured in the coal pile.

It is to be regretted that Mr. Taylor criticized Messrs. Herrle and Gleeson so strongly, and assumed that they were "analytical chemists without engineering experience." Furthermore he introduced extraneous matter when he talked about zeolites, which was wholly aside from the subject. CHEMICAL ENGINEER.

Chemical Industry in Sweden

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your journal, vol. 22, No. 10, page 464, in the article "Chemical Industry in Sweden" there is found the following point: "There are a number of works established for the production of chromium salts, but only one of them remains and its future is dependent upon protection, according to the report published in the *Journal* of the Society of Chemical Industry."

The original report was mistaken. Our factory for chrome alum in Hagge, formerly belonging to Sandsta Elektriska Smältverk, carries on its production by a new method, invented by me, and we have no intention to demand protection. Our company not only sells the chrome alum to Swedish tanners, but moreover exports to Norway, Denmark, Finland, Germany and Czechoslovakia.

I would be obliged if you would correct this point in your journal. G. H. HUITMAN.

Director of the A. G. Metalloxider.

Stockholm, Sweden.

[1]CHEM & MET. ENG., vol. 22, No. 12, p. 532.
[2]CHEM. & MET. ENG., vol. 22, No. 6, pp. 269-272.

Conserving Radium as a National Asset

To the Editor of Chemical & Metallurgical Engineering

SIR:—I noticed your interesting editorial of April 7 on "Conserving Radium as a National Asset." I thought you might be interested in a few aspects of the question with which you are doubtless acquainted, but which were not mentioned in your editorial on this subject. It has been estimated at the Harvard Medical School that about 1 g. of radium element would be required for each 1,000,000 of population to treat efficiently the occurrence of cancer. Of the 110 to 120 g. that would be required according to this estimate, perhaps not more than 20 g. is now in the hands of institutions where it is being efficiently used.

The question has been considered by some authorities whether legislation is not justifiable, prohibiting entirely the use of radium for luminous paints. The hardship that might be worked on this industry would not be so great as it might appear on first thought. Mesothorium as a byproduct from the thoria industry is eminently suited for use in luminous materials; has a half-life of about 6⅔ years, corresponding roughly to that of the luminous paints themselves. On the other hand, its very short life compared to that of radium does not render it nearly so suitable for therapeutic purposes. The prospects are that about 4 g. equivalents of mesothorium can be supplied as a byproduct from the thoria industry in the United States annually. This might or might not take care of the total needs of this industry, depending upon its growth, but would be about all that could be expected from this source unless monazite sand were worked primarily for mesothorium, letting thoria become the byproduct. It is doubtful if mesothorium could stand this expense, certainly not for therapeutic purposes.

The general hardship that might be worked by such legislation on radium producers in cutting them off from the market for luminous materials could be justly compensated by an offer of Congress to buy at a fair price all the radium that they could produce. This could then be disposed of by several different plans—either held for sale to hospitals or loaned to them, or, if Congress felt sufficiently generous, presented to them. The total appropriation required to produce radium up to the estimated needs of the country would be about $10,000,000 or $12,000,000—a very small expenditure considering the tremendous importance of the object. The material accumulated would be useful for hundreds of years; a delay in putting some such program into effect might preclude its ultimate possibility at any cost.

You have touched in your editorial on a very large question of public interest and one that I feel ought to be kept constantly in mind. It is improbable that anything effective can ever be done without an active insistence from the medical profession of this country. The signs that such a sentiment is growing within the profession are very encouraging, but its development may be so slow that it will come to a climax too late. That appears to me to be the great danger of the present situation. S. C. LIND.

Golden, Col.

Relationship Between Dendritic Structure and Ferrite Mesh

Fir-Tree Crystals Do Not Influence Directly the Location of Ferrite Shells Either in Ingot Structure or After Drastic Heat Treatments, While the Physical Properties of Normalized Castings Depend Primarily on an Improvement of the Pearlitic Kernels by Gradual Diffusion of Segregates

BY FEDERICO GIOLITTI

WHOEVER is occupied with "normalizing heat treatments"—those reheatings designed to obliterate ingot structure thoroughly and equalize completely any minor segregations of soluble elements—such a one has often had an opportunity to observe anomalous results which are difficult if not impossible to reconcile with the elementary facts plotted in the commonly used equilibrium diagrams. His technical problems are often much too varied and complex to fit into the relatively simple generalizations accepted at present in metallography, depending as they do on the phase changes at different temperatures in the state of solid solution or the state of aggregation of the respective components, modified in turn by the allotropic transformations in the iron. But in addition to this state of affairs, indicating the necessity of seeking data for the completion of metallographical theory, one can readily call to mind many unsolved problems evidently closely connected with theoretical metallurgy and yet closely related to heat-treatment practice.

I have published in collaboration with Dr. P. Forcella in *La Metallurgia Italiana* (vol. 6)[1] a discussion of one of the latter class of phenomena, namely, the relationship between dendritic structure and excess constituent, which was investigated incidentally to a very extensive series of thermal studies. These, it may be said, consisted of analyzing the autographic differential cooling curves of two samples of steel from the same piece, subjected simultaneously to known heat treatments. It may be said that in a great many cases the form of these differential curves (especially for certain types of steel) could not be harmonized with the commonly accepted ideas of diffusion serving as a basis for logical normalizing practice, and in general did not reflect as well as would be imagined the known history of the pieces studied.

A second group of phenomena belonging perhaps to theoretical metallurgy is comprised by facts about the morphological or crystalline character of the metallic phases at various temperatures and after various heat treatments. These will be touched upon in the course of this discussion, from a standpoint already developed by the author in "Crystallography of Alpha and Beta Iron," published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 22, No. 13, p. 585 (March 31, 1920), at which place the relations were discussed which should apparently exist between the structure of the pro-eutectoid ferrite and the forms of the primary austenite crystals.

A material was selected analogous to that studied closely by Tschernoff, and which develops clearly defined dendrites in what is generally considered to be the characteristic shape of freely-growing solid solution crystals. This metal was an acid open-hearth nickel steel of the following composition:

C	0.42	S	0.008
Mn	0.60	P	0.02
Si	0.22	Ni	2.02

The steel itself was cast into 1-ton, square ingots,

[1]These studies were partially published in *La Metallurgia Italiana*, 1913, p. 804: "On the Control of the Preliminary Heat Treatment of Steel in Large Masses," by F. Giolitti and S. Zublena, and more fully analyzed in the present author's book, "Preliminary Heat Treatment of Soft and Medium Steels."

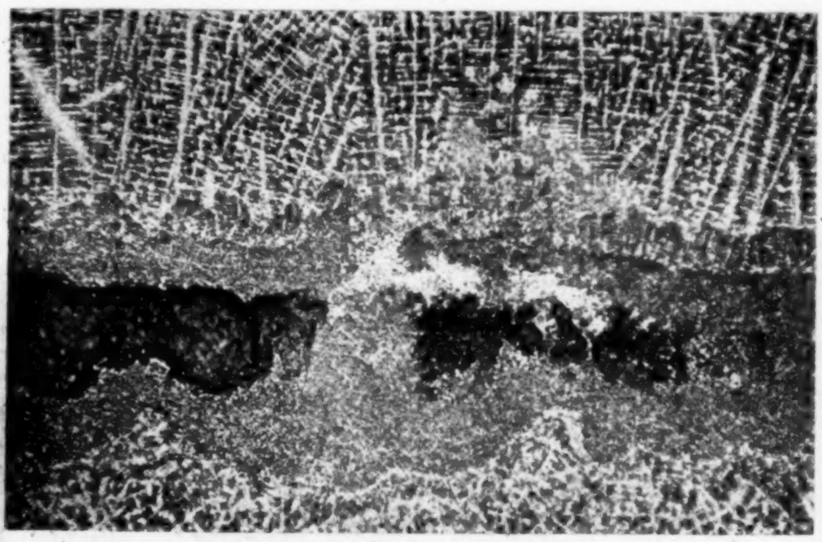


Fig.1

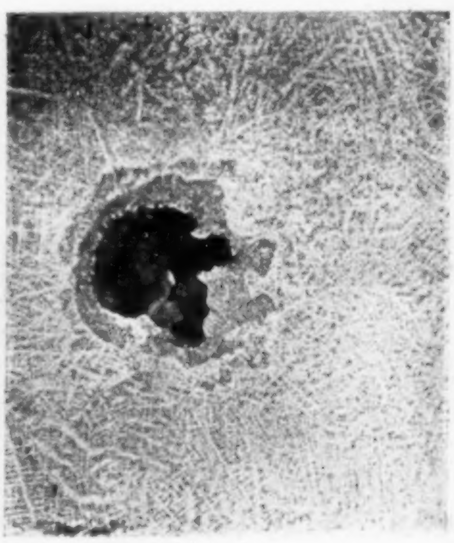


Fig.2

FIG. 1. Section cut along axis of ingot. Cavity extending from left to right represents the pipe, which, of course, was vertical in the original ingot. × 1. Etched 1 hr. with 20 per cent H_2SO_4 at 60 deg. C.

FIG. 2. Cross-section showing structure immediately surrounding axial pipe. × 1. Etched 1 hr. with 20 per cent H_2SO_4 at 60 deg. C.

FIG. 3. Free ferrite in ingot, uncontaminated by slag. × 80. Etched in 5 per cent HNO_3 in amyl alcohol.

FIG. 4. Ferrite and dendrite photographed after duplex etching. × 10.

FIG. 5. Part of Fig. 4, magnified 65 diameters.

400 mm. on a side. One of these was cropped somewhat above the bottom of the pipe, and the body of the ingot split along its axis. Figs. 1 and 2 respectively show, at about natural size, the structure surrounding the shrinkage cavity, after etching the polished surface for 1 hr. with 20 per cent sulphuric acid at 60 deg. C. and then slightly polishing the relief with finest emery cloth. Dendritic structure is very clearly exhibited.

Passing over the very interesting change in the metal at the walls of the cavity, the experiments described below will all be made on samples well back into the body of the ingot, and unaffected by any such variation. If such a test piece was highly polished and lightly etched by a 5 per cent nitric acid solution in amyl alcohol, delicate veins of ferrite were seen tracing a network of kernels several millimeters across. The problem now before us is to determine whether there appeared any relationship between form and disposition of dendrites and meshes.

First, it was necessary to show that the ferrite was uncontaminated with slag. I had already determined that granules of slag are sometimes associated with ferrite in certain characteristic forms and positions, which observations I hope to present in detail in a later paper. However, as shown in Fig. 3 (at 80 diameters), the veinlets are free from visible non-metallic inclusions, and consequently their location is independent of flocculated slag, at least.

DUPLEX ETCHING

The most evident method of showing how the two structures—that is to say, the free ferrite and the primary dendrites—are disposed each to each was to develop both dendrites and ferrite mesh on the same surface. Since the sulphuric acid attack which develops the fir-tree appearances is the more drastic, it must be used first. Then in order to present a reasonably flat surface for photography after the subsequent nitric attack to develop ferrite, the pitted surface must be repolished, but not heavily enough to plane the surface to the bottom of the depressions defining the primary structure.

After such manipulation, the appearance of a sample at 10 magnifications was photographed as shown in Fig. 4. Examination at once indicates that the veins of mesh-like ferrite do not correspond in any way to elements of the primary crystallization. Thus, one of the larger dendritic aggregations falls entirely in the interior of a large cell in the center of the illustration, so that no vein of ferrite develops on its branches. Only in some cases, as at the bottom of the view, do the veins appear to follow axes of crystalline branches, whereas in many other parts—toward the left and center—the ferrite has a course entirely independent of dendrite branches, cutting them often nearly at right angles, and crossing several cavities en route from branch to branch. This independence of the deeply-dug relief is strikingly shown in Fig. 5, representing a central portion of Fig. 4 magnified to 65 diameters.

This method of etching is open to the objection that a great quantity of free ferrite could exist, ranged along the bottom of the etching pits, and never be developed or seen by the nitric-acid etching. So in order to avoid such a contingency, I utilized the method of making successive photographs of one area. In this procedure, an exposure was first made of a polished surface etched with the nitric-amylic solution, so as to exhibit the ferrite system in its entirety, and a second photograph taken of the same surface after deep etching with hot sulphuric acid, developing the dendritic structure exclusively. Extreme care was used to make the negatives at exactly the same

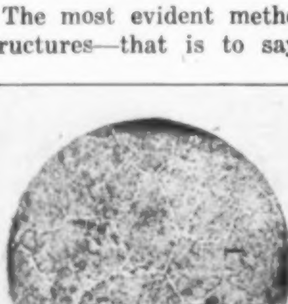


FIG. 6. Ferrite mesh. Etched in amylic solution of HNO_3. × 3.

FIG. 7. Dendritic structure underlying Fig. 6. Etched in hot H_2SO_4. × 3

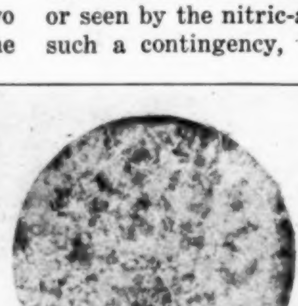


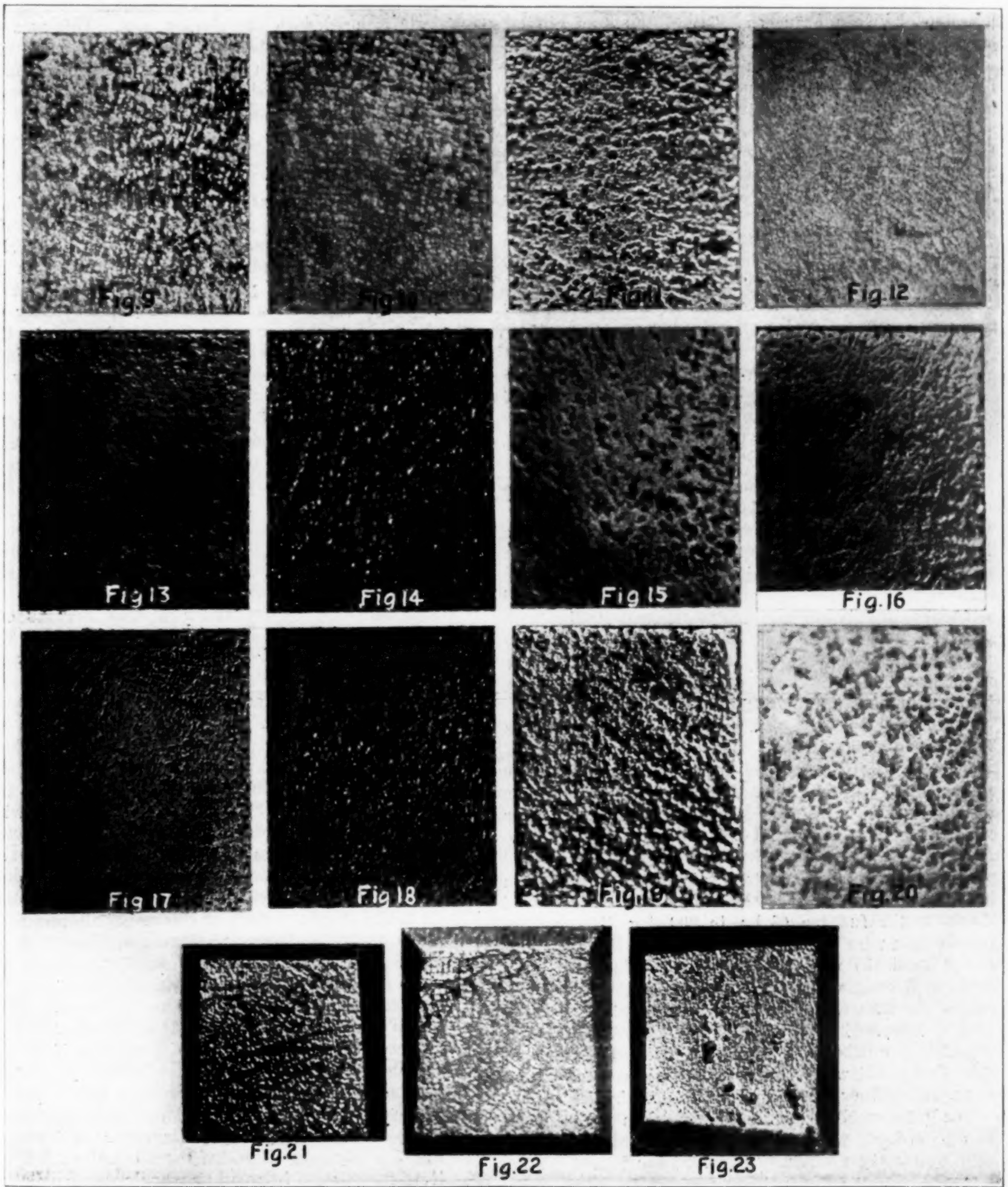
FIG. 8. Negatives of Figs. 6 and 7 superposed in printing frame.

magnification, and of exactly the same field. Then the two negatives were properly superposed in a printing frame, correctly oriented by the use of suitable reference marks, and a single positive made.

Since the glass plates have a considerable thickness, one of the developed films cannot be in close contact with the sensitized paper, and its print will necessarily be somewhat blurred. However, if this one is the negative showing the dendritic system, its print will not suffer, because by its nature it consists of ill-defined elements at best. Consequently a greater deficiency in sharpness of contour does not affect its utility for determining the structural relations we are studying.

In this manner several samples of the ingot were etched and photographed, giving prints similar to those reproduced in Figs. 6, 7 and 8. Fig. 6 shows a surface etched with nitric-amylic solution, Fig. 7 the same area after etching in hot sulphuric, and Fig. 8 is printed from the superimposed negatives.

A study of these and other prints made in the same



FIGS. 9 TO 23. DENDRITIC STRUCTURE DEVELOPED BY DEEP H_2SO_4 ETCHING IN SPECIMENS 1 TO 15 INCLUSIVE
Figs. 9 to 20—Magnified 10 diameters. Figs. 21 to 23—Magnified 3 diameters.

way merely confirms with certainty the observations deduced from Fig. 4, namely, that if in some regions the veins of ferrite appear to accompany the depressed areas separating principal branches (as at the bottom of the figure), there is a much larger number of cases where the veins do not accompany dark depressions, in fact have a course entirely independent of the axes or edges of the limbs. In some of the photographic exposures veinlets of ferrite were occasionally found passing down the ribs of dendrites, but in other prints or even in the same plate, other veinlets favored the depressions between branches. Other ingots of similar steels gave results in every way concordant with these.

For the ingot steels examined, therefore, it seems to be proved that there exists no rigid or constant relation between the reciprocal positions of dendritic elements and ferrite meshwork. Such a fact, if broadly confirmed, would be of greatest importance to metallographers and metallurgists, since the secondary crystallization (i.e., of ferrite or cementite from austenite) is usually regarded as being intimately affected by the system of dendrites, and the position of the ferrite meshwork determined by the difference in carbon concentration, axis to periphery, of the primary austenite. Ziegler[2] and Oberhoffer[3] have indeed advanced the view that accumulations of slag particles have a preponderating effect on the orientation of ferrite mesh; but even this view depends upon the fact that the primary crystallization process determines the location of any segregations of impurities.

Impotence of Single Anneals

To extend the observations it appeared natural to study the variation in relations, ferrite to dendrite, which may be produced by such heat treatments as are known definitely to break up the original ferrite in ingot structure. Such a study might perhaps throw light on the origin of the two crystalline systems, primary and secondary, and by correlating the thermal studies with a careful series of mechanical tests, interesting conclusions might be drawn concerning the specific influence of each structure on the strength, ductility, toughness, fracture and other important physical properties.

Therefore a series of prismatic test pieces about 35 x 35 x 200 mm. in dimension were cut from the ingot first described. Various reheatings were conducted in a small tube furnace, heated electrically by platinum resistance ribbon. A cold specimen was placed in the cold furnace, and current switched on sufficient in amperage to bring the temperature up to the desired point in about 1.5 hr. After remaining at the given heat for the desired time, the sample was either cooled slowly in the furnace (6 hr. to 200 deg. C.) or more rapidly in a wire basket in air. The last three coupons (13, 14 and 15) were given drastic single, double and triple heat treatments, considered in practice most efficacious to transform profoundly the crystalline structure of unworked ingot steel. Table I gives the details. The Brinell number was taken on a machined surface at least 5 mm. below that exposed during heat treatment, so as to avoid any softening due to decarbonization.

The same machined surfaces were then polished and double etched, with a light intermediate polishing, exactly like the procedure described for Fig. 4. Figs. 9 to 20 inclusive show the surfaces of specimens Nos. 1 to 12 inclusive after the deep etching by hot sulphuric acid, and Figs. 24 to 35 their microstructure after a subsequent etching for free ferrite.

As is seen by Figs. 9 to 20 of the etching pits, none of these single heatings, followed by leisurely coolings, has suppressed or sensibly subdivided the dendritic structure, an observation of great interest. Neither has the ferrite meshwork in the samples heated to 700 deg. been destroyed (Figs. 24 to 27), nor has their orientation been changed in any way to one more regularly ordered with the etching pits. This was to be expected, however, since a differential heating and cooling curve taken with Le Chatelier-Saladin apparatus, depicted in Fig. 39, shows that the first transformation point on heating is above 700 deg. C.

Redeposition of Ferrite on Annealing

On the other hand, beginning with the fifth sample (Fig. 28) the heat treatment has caused the carbide in the pearlite kernels to go into solid solution in β or γ iron, and as the temperature increases the ferrite meshes also are absorbed by this austenite. Then on cooling excess ferrite is precipitated into a new meshwork, whose aggregation depends upon the velocity of cooling and, according to many investigators, upon the system of primary crystals. That the size of secondary ferrite mesh is dependent upon velocity of cooling is confirmed by a comparison of Fig. 28 with 29, Fig. 30 with 31, Fig. 32 with 33, and Fig. 34 with 35, each pair of which were reheated in an identical manner, but the even numbered micrographs containing larger pearlite kernels and coarser ferrite shells were cooled much more slowly.

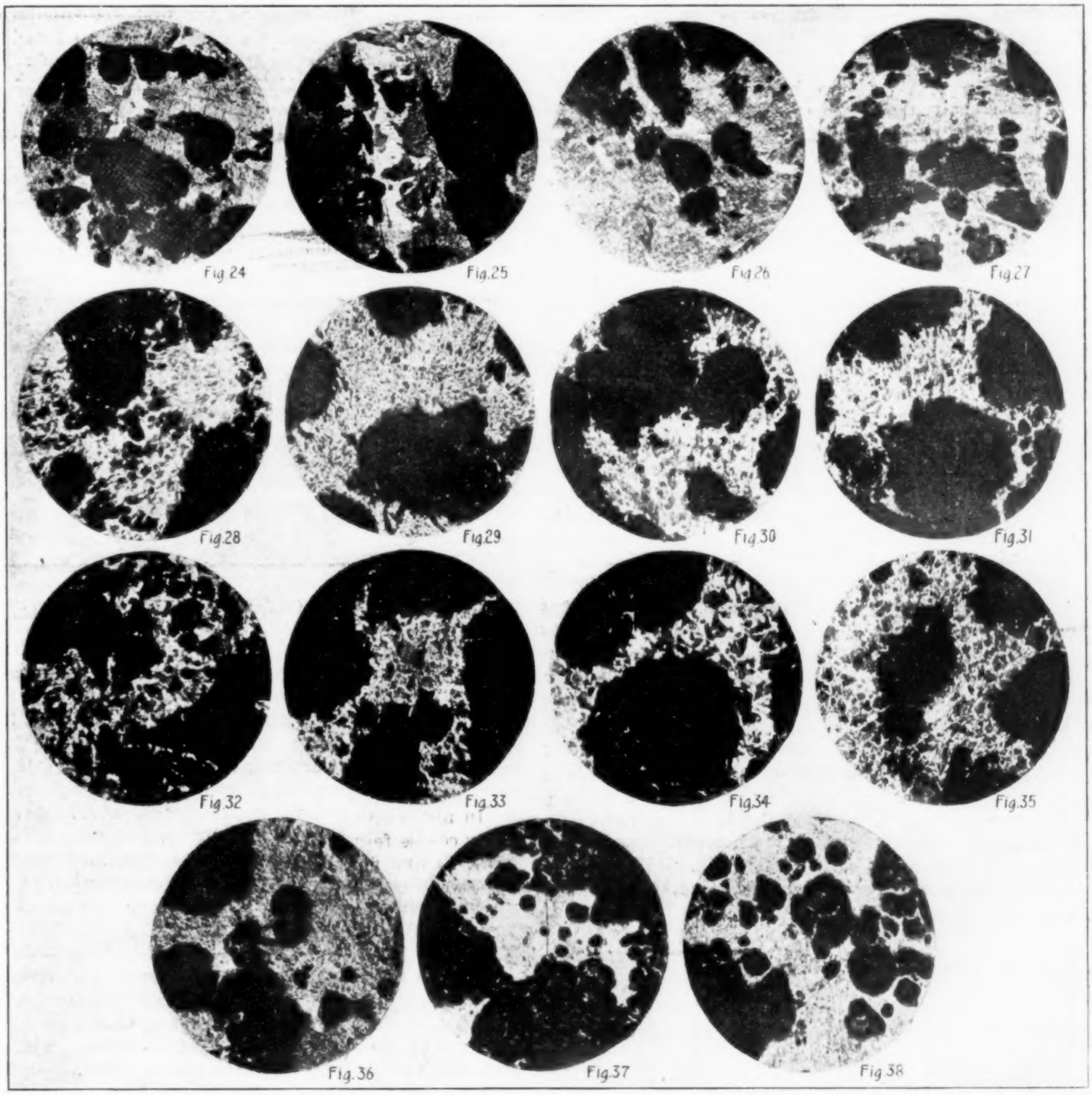
In nickel steels such as the one under examination a very coarse ferrite mesh is especially easily transformed into a very fine network, even by a single reheating followed by a normal cooling.

These well-known facts are mentioned only to call attention to the deduction which can be made from the same micrographs that the dimensions of the elements forming the ferrite mesh depend upon the time and temperature of the precedent heating, as well as upon the velocity of cooling. Comparing micrographs of pairs of samples whose history varies only as to the time at a high heat, it is seen that the ferrite crystals are larger in proportion as the temperature is high and the sustained time is long (Fig. 34). But if we hold with many authorities that this gradual and regular increase in ferrite meshwork is a consequence of a similar increase in the dimensions of the primary crystal constituents in the steel, a corresponding indication should appear in the microstructure of this series of specimens. Examination of the twelve photographs, Figs. 9 to 20 inclusive, shows no indication of such growth in the dendrites developed by hot sulphuric attack.

Unquestionably these two systems of crystals, dendrites and mesh, are morphologically independent during simple reheatings to 900 deg. C. Therefore if ferrite mesh is dependent upon a system of primary crystals, the primary crystals in nickel steels in turn must be independent of the dendrites developed by deep etching. Studies made by superposing photographs as described for Fig. 8 dimly suggest that if there is any such hypothetical interrelation between primary crystals (that is those which first separate from the cooling liquid) and the fir-tree structure appearing after hot sulphuric acid

[2] "Sur la crystallisation du fer alpha," *Revue de Métallurgie*, 1911, vol. 8, p. 664.

[3] *Z. a. org. Chem.*, vol. 81, p. 156.



FIGS. 24 TO 38. FREE FERRITE CRYSTALS DEVELOPED BY ETCHING SPECIMENS 1 TO 15 RESPECTIVELY IN 5 PER CENT HNO_3 IN AMYL ALCOHOL. × 40

attack, it is at most an "agglomeration" effect, where the different branches of the dendrites may be built up by the union of a large number of minute primary crystals, yet each system seems to be independent of changes and transformations in the other. Such conclusions, if substantiated generally, would modify profoundly the commonly accepted hypotheses connecting segregation of impurities and alloying elements with the mechanism of crystallization during solidification.

Destruction of Dendritic Structure

In order to link up these crystallographic studies with the corresponding mechanical properties, it seemed well to produce if possible a sample void of dendritic structure for use as a basis of comparison. Consequently samples 13, 14 and 15 (Table I) were prepared and photographed. As seen in Figs. 21, 22 and 23, even after the single and double quenching, samples 13 and 14 still possess a dendritic system practically as well defined as any of the others. Only in sample 15, subjected to a triple quench after prolonged heating at very high temperatures, was deep etching unable to develop fir-tree markings.

As could be predicted, the microstructure of these latter specimens (Figs. 36, 37 and 38) does not exhibit any ferrite meshwork at moderate magnifications. Instead, tempering at a heat below the transformation range produces a conglomerate from the solid solution, equalized in carbon content at least by the long sojourn in the austenitic range preceding a drastic quenching.

These simple observations permit one to extend the conclusions already reached in an important direction, and that is that normalizing heat treatments based on diffusing the excess constituent and then preventing its re-segregation by rapid cooling past the critical range are enormously less potent on the dendrite system than

TABLE I.

Specimen No.	Heat Treatment: Heating	Cooling	Annealing	Brinell Hardness	Macrostructure, Fig.	Microstructure, Fig.
1	1 hr. at 700°......	Furnace..........	....	179	9	28
2	1 hr. at 700°......	Air..........	....	179	10	29
3	2 hrs. at 700°......	Furnace..........	....	179	11	30
4	2 hrs. at 700°......	Air..........	....	183	12	31
5	1 hr. at 800°......	Furnace..........	....	179	13	32
6	1 hr. at 800°......	Air..........	....	179	14	33
7	2 hrs. at 800°......	Furnace..........	....	179	15	34
8	2 hrs. at 800°......	Air..........	....	183	16	35
9	1 hr. at 900°......	Furnace..........	....	183	17	36
10	1 hr. at 900°......	Air..........	....	183	18	37
11	2 hrs. at 900°......	Furnace..........	....	179	19	38
12	2 hrs. at 900°......	Air..........	....	192	20	39
13	11 hrs. at 1,090°..	2 hrs. to 800°. Then quenched in water	2 hrs. at 580°	217	21	44
14	9 hrs. at 1,000°.... 9 hrs. at 1,050°....	1 hr., 45 min. to 800° C. Then quenched in water 2 hrs. to 800° C. Then quenched in water..........	2 hrs. at 580°	179	22	45
15	10 hrs. at 1,190°... 11 hrs. at 1,160°... 10 hrs. at 1,090°...	2 hrs., 25 min. to 800° C. Then quenched in water. 2 hrs. to 800° C. Then quenched in water. 2 hrs. to 800° C. Then quenched in water..........	2 hrs. at 580°	196	23	46

on the ferrite network, or the crystalline organization which determines its form. Other experiments seem to indicate that one can obtain sensible modifications in form of the dendrites or fir-trees with simple heat treatments, but it is certain that extremely prolonged "heating for diffusion" is necessary to smooth out effectively the local segregations responsible for etching pits ranged along geometric branches.

MECHANICAL TESTS

Returning to the mechanical tests, small Frémont bars shaped like a countersunk rivet (Fig. 41) were cut from each of the fifteen heat-treated specimens. The

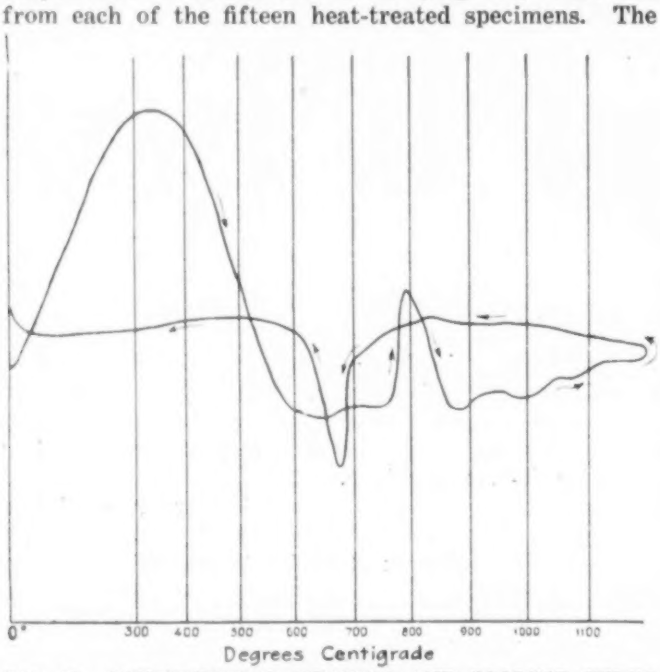


FIG. 39. DIFFERENTIAL HEATING AND COOLING CURVE FOR STEEL UNDER INVESTIGATION

cylindrical part of this little coupon in which rupture will occur is 10 mm. long x 8.2 mm. in diameter. Table II gives the results of the tension tests, and also contains remarks as to the nature of the fracture. Bending tests were also made on the first six specimens, using bars 10 mm. square x 60 mm. long, as listed in Table III. Shock tests in the Frémont impact machine are tabulated in Table IV, using samples 8 x 10 x 80 mm. in dimension, notched on the 8-mm. surface with a semi-cylindrical cut, and the appearance of the fractures given in Fig. 40.

Examination of the test results shows a rough correspondence in certain features to the heat treatments. The latter proceeded from simple to complex by a series of steps, and parallel steps may be discerned in the

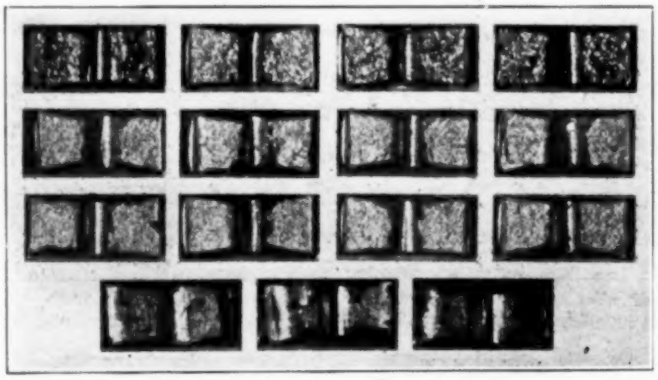


FIG. 40. FRACTURES OBTAINED UNDER IMPACT TEST

structural and mechanical properties. Thus, the dendrite system passes from samples where the heat treatments leave it entirely unaltered to that which produces the most profound transformation possible in practice. Also the character of the fracture, which is always held to be of utmost importance, shows in all three sets of mechanical tests a series of steps from coarsely crystalline or granular to the finest fibrous or silky break. It should therefore be possible to trace some apparent relations between heat treatments, structural constituents and mechanical properties in the unworked nickel steel under study.

CAUSE OF CRYSTALLINE FRACTURE

So-called granules or coarse crystals in the fracture are certainly not essentially due to the development of the fir-tree crystals, but rather are connected very closely with the state of the ferrite meshwork. This is proved by comparing the micrographs, Figs. 9 to 38, with the tabular columns describing the kind of fracture and their appearance as shown in Fig. 40. For gradual stresses (tension), fibrous fractures first appear in sample 5, whose ferrite had hardly been absorbed and the ingot structure therefore but poorly obliterated. From this point on the tension fracture is about the same except for very small variations, until the last three are reached. Normalizing by quenching and tempering produces materially finer fibers in specimens broken under tension.

In the impact test, Table IV and Fig. 40, granular breaks appear in all samples merely reheated, becoming finer as the reheating is the more elevated. Multiple heat treatments (samples 13, 14 and 15) are again able to refine the fracture into a fibrous appearance. However, examination of the micrographs, Figs. 24 to 38, does not show a pronounced variation by steps to correspond to the very pronounced graduations in fracture under impact. For example, sample 6, Fig. 29, has a much finer meshwork than that of sample 11, Fig. 34, yet under impact sample 6 has a fracture fairly de-

scribed as crystalline, and sample 11 as fine crystalline. Apparently, then, in addition to the general effect which ferrite meshwork exerts upon grain size as revealed in fracture, a second unknown influence must be superposed, even though of lesser importance. It seems that this second influence cannot be that of the fir-tree crystals revealed by H_2SO_4 etching, since Figs. 9 to 23 show that the dendritic system remains substantially unmodified. It is not so certain, however, that the various heat treatments, through which the dendrites retain their form and size sensibly unchanged, have not materially changed the absolute concentration of the various elements or compounds (other than cementite) in solid solution with the iron, without dispersing effectively the last parts of the segregations arranged in semi-geometric pattern which are responsible for the appearance of fir-trees on deep etching. Such partial diffusion obviously would not change the arrangement of the etching pits, and any resulting change in speed of acid attack would be difficult to measure.

TABLE II. TENSION TESTS

No. of Specimen	Diameter at Neck, Mm.	Per Cent Contraction	Elongation in Mm. at First Point of Inflection in the Stress-Strain Curve	Breaking Load (Kg.)	Maximum Strain on Initial Cross-section (Kg.)	Maximum Elongation Before Rupture (Mm.)	Kind of Fracture	Remarks
1	8.15	1.33	2.00	3,720	70.45	2.20		
2	7.75	10.70	0.75	3,720	70.45	2.80	Coarsely crystalline	Stretched throughout
3	7.85	8.35	0.75	3,845	72.84	2.75		
4	8.00	4.83	0.95	3,553	67.29	1.75		
5	6.60	35.20	0.25	3,678	69.66	4.00		
6	7.20	22.93	0.25	3,845	72.84	3.05		
7	7.00	27.14	0.25	4,014	76.00	3.90		
8	6.60	35.20	0.25	4,180	79.16	3.80	Fibrous	Necked
9	7.05	26.16	0.40	3,845	72.84	3.25		
10	7.05	26.16	0.35	4,180	79.16	3.45		
11	6.90	29.21	0.40	3,762	71.23	3.55		
12	7.15	23.98	0.40	3,971	75.20	3.05		
13	5.90	48.23	0.40	3,556	67.35	4.75	Fine fibrous	Necked
14	5.85	49.10	0.40	3,853	72.95	4.60		
15	5.85	49.10	0.50	3,512	66.50	4.10	Medium fibrous	Necked

More Than One Crystalline System Influences Physical Properties

Further analysis of the mechanical tests yields interesting confirmation of the hypothesis that two distinct systems are superposed in effecting variations in physical properties. For instance, in the tension tests—Table II—the ultimate strength wanders somewhat vaguely between extreme values of 66.5 and 79.16 kg. per sq.mm. with no reference whatever to variations in heat treatments. Brinell hardness as reported in Table I also shows similar unconformity.

On the other hand, the first four samples possessing the original ingot structure act precisely as would be expected from a conglomerate of two different elements of considerable size, yet with one, the ferrite mesh, predominating in influence. Thus, only these four samples were stretched throughout their entire length, "necking" but little at the break, and exhibiting a mottled surface appearance due to so-called "lines of Lüders." The small contractions of area are a natural consequence of this condition. Samples 5 to 12, reheated above the critical range, have other properties varying independently of the condition of the free ferrite. Thus the contractions do not vary over a great range, but No. 9, with a much coarser network than No. 6, has a larger contraction, as is even more markedly the case when comparing No. 11 with No. 7. On the other hand, the last three samples, containing no ferrite microcrysts, have the largest contraction.

TABLE III. FLEXURE TESTS

No. of Specimen	Maximum Load, Kg.	Deformation at Maximum Load, Mm.	Kind of Fracture	Remarks
1	2,887	2.80	Crystalline	Strained throughout
2	3,174	3.00	Crystalline	Strained throughout
3	3,174	4.55	Crystalline	Deformed only near fracture
4	2,927	4.70	Crystalline	Deformed only near fracture
5	3,160	6.20	Fibrous	Deformation well localized
6	3,512	7.75	Fibrous	Deformation well localized

Fracture in Tension Follows Ingot-Ferrite

In order to determine if possible the exact influence which the fine ferrite meshwork existing in the original ingot structure has upon the course of fracture under tension, a flat specimen of the shape recommended by Frémont and illustrated in Fig. 4 was cut and polished on both sides. This sample not only permitted easy photography, but would exhibit in one specimen the strain-effects varying from moderate forces to those producing rupture. In order to examine simultaneously the lines of Lüders (or deformation figures) and the ferrite network, a longitudinal strip was etched down the axis of the test piece by directing a small rivulet of amylic-nitric reagent across the polished surface, with a result pictured in Fig. 41. Elements of the large ferrite network are thus dimly developed.

After breaking, the piece was again photographed as shown in Fig. 42. If this illustration be examined attentively, paying particular attention to the prolongation of the ferrite veins from the areas where they are developed by acid attack through the areas where they are developed by intense strain, the following facts are apparent:

First, the surface along which total rupture took place, even if the slip was only momentary, corresponds entirely to elements of the large ferrite mesh.

Second, elements of network do not seem to be related to the lines of Lüders. This is especially evident where the surface of the sample begins to enlarge. Here several ferrite veins appear as a direct prolongation of those developed by acid attack, traversing in many places well developed strain figures, which latter are in fact very much smaller in dimension than the kernels enclosed by ferrite shells.

TABLE IV. IMPACT TESTS

No. of Specimen	Total Energy Absorbed Kg.-M.	Kind of Fracture (Fig. 40)
1	12	
2	18	Coarsely crystalline
3	20	
4	20	
5	12	
6	12	Crystalline
7	13	
8	13	
9	31	
10	32	Fine crystalline
11	30	
12	30	
13	32	Short fibers
14	32	Fine long fibers
15	32	

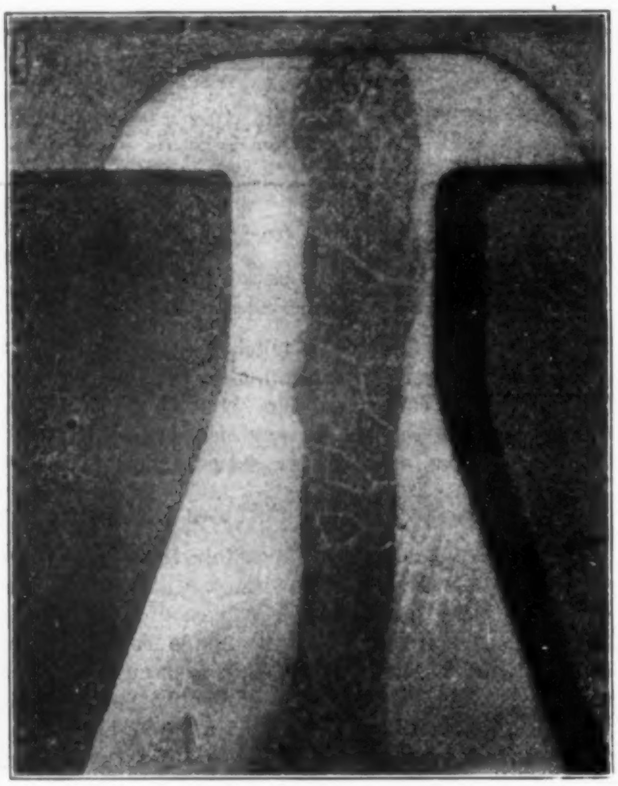


FIG. 41. FLAT TEST BAR, ETCHED PARTIALLY WITH AMYLIC-NITRIC REAGENT

This experiment makes it very clear that the elements of the large ferrite meshwork existing in ingots constitute the surface of lesser resistance along which rupture upon slow stressing takes place considerably before failure at joints of the finer-grained structural system responsible for the deformation figures.

Effect of Reprecipitated Ferrite

Elongations observed at the yield point give a very clear confirmation that in addition to free ferrite a second system of crystallization is increasingly potent in its effect on physical properties. Very large stretches are shown in the first four samples having ingot structure, but the values fall to a minimum immediately the reheating passes the critical range. From this point on, the elongation at yield point increases as the normalizing treatments become more extended, suffering a sudden increase with sample 9, the first having a reheating at 900 deg., but, as before, the values do not seem to have much connection to the amount or disposition of the free ferrite shown in the micrographs. Finally, analogous observations may be made when analyzing the total elongation at rupture. These values, small for the first four samples, increase considerably for the next eight pieces, and still more for the last three, multiple-treated, in fact appearing to be roughly inverse to the size of ferrite mesh.

When testing for static flexure (Table III), the total rupture load does not vary greatly, while the corresponding maximum deformation increases greatly as the heat treatments become more efficacious in eliminating ferrite meshwork. In this case as well, ingot structure is accompanied at failure by mottled surface and non-localized deformation.

Testing under impact brings out the same partial independence of ferrite system. From sample 5 onward there is an undoubted increase in toughness with extended thermal treatment. Beginning with No. 9 (annealed at 900 deg.) there is an especially great resistance to shock, without there being any notable variation in the condition of the free ferrite over that of the four preceding, while from No. 9 on the toughness remains about stationary, even though samples 13, 14 and 15 have extremely fine ferrite. This condition is analogous to that holding for the values of elongation at the elastic limit, an important observation suggesting more than a coincidence and indicating an intimate connection between these two properties. However, it should be remembered that under shock testing the action of a continuous ductile ferrite cement such as exists in the ingot under observation may well be profoundly different than when working under slowly applied loads. Impact may, in fact, cause failure in the kernels rather than failure in the shells.

Conclusions

Such observations establish the following points and define somewhat better the specific function of the ferrite network, previously noted only in general manner as being independent of that of the other co-existing structural systems.

First, in the 2 per cent nickel steel examined, the position and form of ferrite elements is entirely independent of the position and state of the elements of the dendrite system, both when existing totally or partially in the large meshes characteristic of ingot structure, and when the latter is wholly altered.

Second, the elastic behavior of the steel with its original ferrite meshwork is quite unique. The pure iron constitutes a *continuous* plastic system, much more

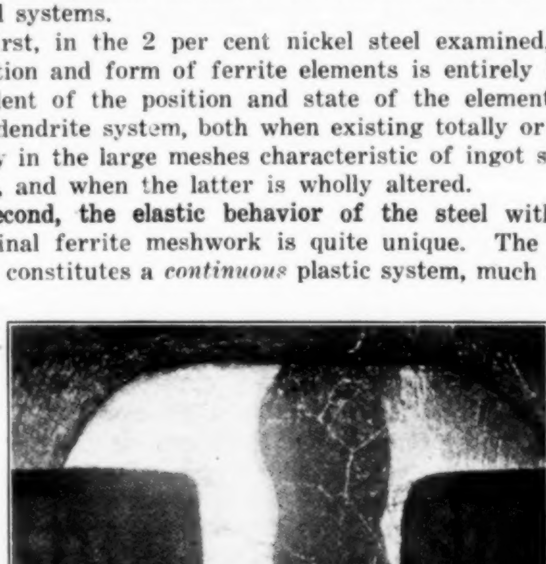


FIG. 42. SAME BAR AFTER FAILURE IN TENSION, SHOWING LÜDERS LINES IN KERNELS AND SLIPPAGE ALONG THE FERRITE SHELLS

easily deformed under gradual stress than the elements of the other structural systems superposed upon it. Under load the total resistance of such ingot metal is determined primarily by the strength of the meshwork, and the elastic properties of such ingot metal conform to those of metals containing a continuous plastic cement binding together kernels of greater toughness and ductility.

Third, once the ferrite meshes have been absorbed in austenite on reheating, it reprecipitates in discrete particles (as has been shown in my previous paper)[4] corresponding more nearly to its own crystalline habit, and simulating a meshwork but in reality remaining essentially discontinuous. In this case the fine and compact elements of the superposed system are more or less continuous. Hence the now isolated ferrite crystallites no longer carry the totality of stress nor exercise a major influence by virtue of their plastic nature, a fact immediately reflected in the physical tests the moment the steel has been annealed above the transformation range. Appearance of fracture, ductility, and toughness immediately show a sharp discontinuity, and thereafter vary with the degree of "normalizing heat treatment" rather than the amount of free ferrite or its state of aggregation.

Proper Heat Treatment Makes Cast Nickel Steel Equal to Best Forgings

Fourth, once these large ferrite shells are destroyed, even heat treatments which allow considerable accumulation of crystalline ferrite in roughly arranged meshwork do not produce corresponding variation in the fracture or other physical properties developed in tension, bending or impact, an indication that they have not yet become truly continuous. Unexceptionably ductile, strong and tough steel with a fine fibrous fracture is obtained from unworked metal only by drastic multiple heat treatments, a conclusion evidently of the highest practical importance in the making of shock-resistant castings of this alloy, and substantiated in everyday manufacture of such important pieces as elements of gun mountings. Many illustrations of physical tests of such pieces are given in the author's book mentioned at the outset of this article.

Fifth, the fracture, ductility and toughness vary consistently with variation in heat treatment, when samples free of ingot structure ferrite are considered. These physical properties do not vary consistently with the microscopic appearance of the ferrite, but appear rather to depend upon the super-position of one or more additional systems of structural elements endowed with characteristic critical intervals. The chief added influence appears to me, if only by the process of exclusion, to be related in some way to the original crystallization of the ingots, and probably is due to improvement of the pearlite ground mass by the gradual diffusion during drastic reheating of those small heterogeneities in the dendrites which are responsible for the etching pits arranged in fir-tree form.

Sixth, a correct explanation of the genesis and transformation of the ferrite system in hypo-eutectoid steels cannot be one involving a close relation to the dendritic system of primary solidification. It must at least be admitted that the elements of the dendritic system are individual crystals resulting from colonies of crystals of secondary origin.

[4]CHEM. & MET. ENG., vol. 22, p. 737 (April 21, 1920).

Montan Wax

By Clarence J. West

Bad as our own fuel troubles have been of late, those of England have been worse. The effort to find relief has led to extremely interesting developments. Of special significance are the achievements in furthering the chemical values obtainable in connection with the use of fuel.

Repeated rumors have come from more or less official sources regarding startling developments in these fields. The latest report (the *Nation's Business*, April, 1920, p. 76) calls attention to the development of lignite as a possible solution of Great Britain's oil problem, and specially to the production of Montan wax from this lignite which, up to the present, has been a complete monopoly of Austria and Germany.

Nature and Uses of Montan Wax

Montan wax comes into commerce as a white, high-melting candle-like material. It is not a paraffine, but a mixture of an acid and an alcohol. While it decomposes when distilled at ordinary pressure, it may be purified by distillation with superheated steam in vacuum.

Montan wax is valuable as a substitute for carnauba wax in the manufacture of shoe polishes, and is also used in the manufacture of phonographic records, and as an insulating material in place of ceresin (purified ozokerite).

Montan Wax From Pyropissite

The best source of Montan wax is the mineral pyropissite, which may contain as high as 70 per cent. This supply, however, is largely exhausted. The next best material is lignite from Thuringen, Saxony, with about 9 per cent Montan wax, although in exceptional cases as high as 20 per cent has been obtained. All the other lignites examined run somewhat below 5 per cent Montan wax.

Montan Wax From Lignite

Some years ago Arthur D. Little, Inc., made an exhaustive examination of the lignite deposits of Canada, with special reference to the possibility of obtaining Montan wax. Samples were obtained from Bienfait, Sask.; Taber, Lethbridge, Drumbellen, and Morimville, Alta.; Nicola, B. C., and Princeton, B. C. Samples of brown lignite from the Estavan district of southern Saskatchewan were also examined. In only one case was Montan wax (benzol extract) found, and that was so small as to be commercially unimportant. When this work had been completed, it was learned that the Standard Oil Co. had made a similar search with similar results.

Montan Wax From Peat

Ryan and Dillon (*Proc. Roy. Dublin Soc.*, 1909) have obtained waxes of very similar properties from certain deposits of Irish peat. Peat is one of the stages lower than lignite in coal formation and so a large number of samples of peats from various Canadian bogs were examined in the same way. All of them were found to contain a small percentage of wax, very similar in characteristics to Montan wax, though not identical with it. In all cases, however, the amount was from 5 per cent downward (on the dry basis) and would not justify the commercial utilization of peat for this purpose.

Information Department,
Arthur D. Little, Inc.

Report of the Rubber Division Meeting and Cellulose Symposium of the A. C. S. at St. Louis

Notes on Physical Testing—Bromine Addition—Value of Shoddy—Recovery of Solvents—Determination of Sulphurs—Accelerators—Dispersion of Pigments—Effect of Compounding Ingredients—Microscopic Testing—Colloidal Studies—Testing of Pigments—Papers on Cellulose

THE second meeting of the Rubber Division of the American Chemical Society, which was held at St. Louis, April 14 and 15, 1920, was even more of a success than that of last September in Philadelphia. The rubber chemists of the country are becoming acquainted. They have met, admired, and are beginning to understand and appreciate the other fellow. Information may be divided into two classes, the purely scientific and that which has trade value, such as trade secrets, formulas, etc. It is recognized that the latter should not be made common property, but it has always proved true that free and open discussion of the fundamentals not only puts the industry on a firm basis but gives one fresh inspiration, new ideas and new applications. The benefits of co-operation in things scientific are apparent. The whole tone of this meeting reflected the willingness of the members to discuss the scientific fundamentals of the industry with material benefit to all concerned.

The papers were not so numerous as at Philadelphia and the discussion of each was in every case of considerable value. It is to be hoped that before the next meeting the members of the division will be provided with abstracts of the papers to be given ahead of time so that they can collect their own data and enter into the discussions to the fullest extent.

Report of the Committee on Physical Testing

Tentative specifications were presented last September, at which time the matter was referred back to the committee so that comments, criticisms, etc., might be submitted. J. M. Bierer called the committee's attention to an apparent error in the bursting test for hose, which was later found to be a typographical error consisting of the omission of the decimal point. W. W. Evans suggested that for the time being both English and metric systems should be used, but that later we should gradually work over to the metric system. The permanent set test as outlined was criticized as long and cumbersome. On the other hand, if a real measure of plasticity is desired some such test is very necessary. Mr. North said that the test could be shortened to three stretches to 60 per cent of the breaking elongation, each held 3 min., with a 1-min. interval between, measuring 10 min. after the third release. Discussion was closed by passing a motion referring the whole proposition back to the committee, which was instructed to co-operate with all parties interested in rubber testing, e.g., Bureau of Standards, Rubber Association, etc., for the development of methods which will be standard throughout the United States.

Bromine Addition to Rubber

W. K. Lewis and William H. McAdams showed that the addition of bromine to rubber may be quickly measured volumetrically and that the disappearance of bromine when corrected for combined sulphur is a direct measure of the rubber hydrocarbon in the stock. The method is not applicable to determining the coefficient of vulcanization. Certain substances, of which MR is the principal offender, were shown to interfere. Dr. Lewis gave some results which checked the actual rubber content of the stocks very closely.

Relative Value of Shoddy in Mechanical Rubber Goods

The question as to when reclaimed rubber ceases to be economical has always been a serious one for makers of the various mechanicals, such as hose, packing, heels, etc. J. M. Bierer gave his findings, but little as to the methods by which his conclusions were arrived at. He presented a very interesting chart showing variation of relative values of reclaim, scrap, and crude rubber, from which it is possible, knowing the market price of crude rubber, to find the price at which tire carcass and shoe shoddy reclaims become unprofitable. From another section of the chart maximum allowable prices for these scraps, depending as before on the price of crude rubber, may be found.

Recovery of Volatile Solvents

Dr. W. K. Lewis discussed the two methods of solvent recovery, which are by absorption, and by compression and cooling. The first one requires that the spreaders be inclosed and that the solvent vapors be swept away by inert gas, thus preventing explosions. The solvent is washed out of the gas in a manner not greatly different from coal gas scrubbing. A 90 per cent recovery on large-scale operation is possible, but considerable funds are required in the initial outlay.

Where the vapors are more highly saturated the compression and cooling method is satisfactory. Not such a large initial expenditure is required.

Determination of True Free and True Combined Sulphur in Vulcanized Rubber

Dr. W. J. Kelly pointed out that the method of determining combined sulphur by subtracting acetone soluble sulphur from total sulphur is erroneous. The acetone soluble sulphur consists of true free sulphur and sulphur combined with certain resins. These may be separated by treating the acetone extract with alcohol previously saturated with sulphur. In this way the resins with their combined sulphur dissolve but leave behind the true free sulphur.

When the extracted sample is boiled with alcoholic potash, practically all of the acetone insoluble resins with their combined sulphur are saponified and removed. Boiling alcoholic potash also removes any sulphur that may be combined with rubber proteins.

This is a very valuable contribution, and should give new impetus to the study of the relation between coefficient of vulcanization and physical properties.

C. R. Boggs pointed out that free sulphur may be measured by suspending a roll of copper gauze in the acetone during extraction. Increase in weight gives free sulphur directly.

Small Amounts of Magnesia and Certain Organic Substances as Accelerators

A paper on this subject was presented by G. D. Kratz and A. H. Flower. The authors compared small amounts of magnesia with various organic accelerators. They advanced the opinion that magnesia functions as a secondary accelerator, i.e., it aids other substances, probably always nitrogenous, in producing the true accelerator which is yet to be discovered.

Dispersing Power of Pigments

W. K. Lewis and F. P. Baker stated that the dispersing power of pigments is a very interesting method for comparing average fineness of a pigment with other samples of the same pigment. When for one sample the dispersing power and size of particle, measured microscopically, are known, the average size of particle of other samples may readily be determined. The method consists essentially of working up a weighed quantity of pigment in linseed oil, diluting it with suitable solvent and measuring the weight of the column of liquid required to obscure the filament of an electric light.

Possibility of comparing fineness of different pigments was discussed. J. R. McGregor pointed out that the index of refraction of the pigments and of the liquid media has a considerable influence, at least in some instances, on such results.

Effect of Compounding Ingredients on the Physical Properties of Rubber

Compounding experiments with varying volume ratios of the more common fillers were described by C. O. North. Value of the pigments mentioned is in following order: Gas black, zinc oxide, magnesium carbonate, tripoli, lithopone and barytes. Mr. North proposed a new method for aiming at the effect of the filler on the rubber regardless of how that effect is produced. Values for the ordinary tests were referred back to the actual volume of rubber present.

The practice of making comparisons on a basis of tensile strength is unfair to stocks high in rubber. Tensile at break was advanced as a better procedure. This is secured by multiplying tensile strength as ordinarily obtained by the final length, dividing by the original length and correcting for volume increase during stretching. Such curves are parallel to those for Stevens Tensile Product value.

A visualization of the physical structure of rubber was presented, i.e., the network hypothesis which is based on the assumption that large colloidal aggregates function as elastic fibers and the shorter ones as plastic material. It is not improbable that the chief effect of vulcanization is to lock up these fibers to form a network. The finer the compounding ingredient the more loops there are to this net and the stronger and tougher the stock.

The reading of this paper was followed by considerable discussion. W. B. Weigand stated that his own data checked Mr. North's very closely. He is of the opinion that the effect of compounding ingredients is largely due to their surface energy. The similarity of the views of the two investigators was quite apparent. The only difference is that the one has created a mechanical hypothesis for purposes of visualization, while the other applies the more or less intangible surface energy, adsorption theory of the colloid chemist.

Microscopic Examination of Rubber Products

H. J. Masson and Irene Diner presented a paper on the application of metallographic and biological methods of microscopy to the examination of rubber. This will no doubt prove a very productive field for research. This paper is the first on this subject.

The technique of the authors is to be commended. Unfortunately they did not have the co-operation of any rubber technologist, and as a result their conclusions were somewhat exaggerated. A very interesting series of photographs was shown.

Rubber Chemistry From the Colloidal Viewpoint

E. B. Spear presented a discussion of coagulation, polymerization, and the effect of compounding ingredients on rubber from the standpoint of one versed in colloidal chemistry. It is hoped that quantitative data may be obtained which will permit of practical application of the colloid theories to the rubber industry.

Symposium on the Testing of Pigments

B. F. Goodrich Co. methods of sampling, testing, and analysis of pigments for compounding were described by W. W. Evans. It was found that the methods of other chemists agreed well with those described by Mr. Evans.

New Business

George Oenslager resigned from the executive committee because of an extended visit to the Orient.

Standardized methods of rubber analysis are booked for discussion at the next meeting.

No action was taken toward a unified method of testing crude rubber. It was the opinion of those present that the various manufacturers preferred their own methods, which for the time are probably satisfactory.

The division took a firm stand against the attempt of some manufacturers to sell accelerators to the rubber industry solely under trade names. In the first place the chemists in attendance agreed not to test such accelerators and in the second the Rubber Division promises to declare the true composition of every accelerator so marketed. This action was taken because of the introduction of an accelerator said to consist of starch and sodium hydroxide, and also the growing tendency to incorporate such substances as barium sulphate into accelerators which are sold at high prices per pound. Trade names are not objected to if the true percentage composition of the accelerator is given at the same time. C. O. North, Frederic Dannerth, C. W. Bedford and H. A. Depew took part in the discussion preliminary to the passing of the above motion.

The marked success of this meeting is merely a beginning. It is hoped that the chemists of every rubber company will endeavor to present at least one paper per year.

In closing this review, the efforts of the chairman, Dr. Warren K. Lewis, of the Massachusetts Institute of Technology, who ran true to form in leading discussion and in generally making the meeting a "go," are to be particularly commended. The highly efficient secretary, Arnold H. Smith, of the Goodyear Tire & Rubber Co., is also to be congratulated on the way he handled his work.

Cellulose Symposium

The advocates of the establishment of a Cellulose Section more than proved its desirability both by providing an excellent program and attracting an attendance of nearly 500 members. Through a misunderstanding, the member of our staff who was to report on the papers of this symposium did not do so, but we are pleased to give the following notes as received from Dr. Gustavus J. Esselen, Jr., of A. D. Little, Inc.:

The Mechanism of the Reactions of Cellulose. J. E. Minor. Miss Minor's paper was presented in abstract. It was a continuation of the work, part of which she published in *Paper*, vol. 25, p. 700 (1919). She looks at cellulose from the modern viewpoint, which regards it as a colloid, and on this basis she considered in her paper a number of the reactions of cellulose, such as oxidation, hydration and solution. Her paper is one of the few which have attempted to present cellulose chemistry from the modern viewpoint. It is a very valuable contribution.

Some Observations on the Determination of Cellulose in Wood. S. A. Mahood. Dr. Mahood's paper presented some recent work of the Forest Products Laboratory at Madison, in which they have studied the determination of cellulose in wood samples, with special reference to the degree of subdivision of the sample analyzed.

Nitrocellulose From Wood Pulp. R. C. Woodbridge, Jr. This paper was presented by title. It appeared in the *Journal of Industrial and Engineering Chemistry* for April, 1920, on p. 380.

Notes on the Manufacture of Nitrocellulose. J. O. Small and C. A. Higgins. This paper was presented in abstract form. It contains a very thorough survey of the many important factors involved in the preparation of nitrocellulose for different purposes.

Certain Aspects of the Chemistry of Cellulose Acetate From the Colloidal Viewpoint. G. J. Esselen, Jr. In this paper, after a brief consideration of some of the colloidal principles involved in the preparation and solution of cellulose acetate, the author presented a theory which attempts to explain why alcohol improves the solubility of cellulose in chloroform and tetrachlorethane and to connect this phenomenon with the known fact that cellulose acetate is soluble in mixtures of alcohol and benzol and in phenols, but is not soluble in alcohol mixed with aliphatic hydrocarbons.

Projects of the Preliminary Committee on American Cotton Research. H. E. Howe. This was a brief outline by Mr. Howe of some of the things in which the committee is trying to interest the cotton manufacturers.

Is It Advisable to Form a Section of Cellulose Chemistry? Jasper E. Crane. Since Mr. Crane was on his way to London, this was a letter from him urging the establishment of a section of cellulose chemistry. The symposium at St. Louis was organized by Mr. Crane.

Cellulose Phthalate; Its Preparation and Properties. H. A. Levey. In this paper there was presented some work carried out by the author for the Bureau of Aircraft Production during the war. The object was to prepare a cellulose ester for use in airplane dopes which would not require acetate of lime, either for its preparation or solution. As raw material, powdered cellulose hydrate was used. Owing to the solid character of the phthalic anhydride, considerable difficulty was experienced in the esterification. A product was obtained which the author claimed corresponded to one molecule of phthalic acid combined with eight molecules of cellulose. Because of the low degree of esterification, no solvents had been found for the material. The work was interrupted by the signing of the armistice.

Production of Petroleum in Mexico

It is impossible to give the exact number of wells under exploitation at present in the Mexican fields, if by exploitation is meant the actual extraction of oil from the wells; nor is it easy to determine the daily production of petroleum, since this is dependent on the industrial needs of the companies, the orders they may have pending, and especially on the available means of transportation. On Nov. 1, 1919, the wells actually producing petroleum numbered 305, with a daily production of 317,000 cu.m., or approximately 2,000,000 bbl. Of course, it is not possible to operate the wells continually at full capacity, nor is it reasonable to expect that the productive capacity of a given well will remain constant for an indefinite period; therefore any speculation as to the productive capacity of the wells is only a relative value. However, even though only 50 per cent of the wells be exploited, and allowing for errors in estimating their possible production, it is safe to say that the Mexican wells now under exploitation are capable of producing 170,000 cu.m. of petroleum per day, or about 1,000,000 bbl.

During the year 1919 exports of petroleum from the various ports were as follows:

	Tons
Tampico	6,342,950
Tuxpam and Puerto Lobos	4,638,511
Puerto Mexico	264,482
Other ports	682
Total	11,246,626

About 75,700,000 barrels.

Official figures showing the value of these exports are not available, but 186,500,000 Mexican pesos has been stated as being an approximate value. Taxes collected for the year were 15,203,986 Mexican pesos.

Refineries Under Construction

The Mexican Government has done everything possible to favor and develop the industry of refining petroleum in the country, in the belief that this branch of the industry would lead to the greater industrial development of Mexico by furnishing the necessary derivative products, offering employment on a large scale, and utilizing to a great extent national resources. Therefore, numerous concessions for the establishment of refineries have been granted, and a great number are now under construction. During the year 1918 there were refined in Mexico 3,795,000 tons of crude petroleum, fuel oil occupying the first place among the refined products, with a total production of 2,883,000 tons. During the same year refined products made up 34 per cent of the total exports of petroleum, which amounted to 7,676,864 tons, and it is estimated that during the year 1919 there was exported 2,653,000 tons of refined petroleum products.

Research in the Non-Benzenoid Hydrocarbon Series

A Constructive Discussion Emphasizing Certain Points in Organic Chemistry—Grouping of Open Chain and Non-Condensed Ring Hydrocarbons—Limits of Applicability of Certain Type Reactions—Influence of Adjacent Radicals—Molecular Rearrangement—Field for Industrial Research

BY BENJAMIN T. BROOKS

THE beautiful, interesting, and often facile chemistry of the benzene hydrocarbons has somewhat overshadowed the chemistry of the aliphatic open chain and non-condensed cyclic hydrocarbons. Certainly the chemistry of the former series has been much more fully rounded out. Judging from the customary method of treatment accorded them in our textbooks, there is some confusion in the arrangement of subject matter which does not give the student a proper idea of the close relationships and similarity of chemical behavior possessed by all the non-benzenoid hydrocarbons.

Part of this confusion has probably arisen from the frequent use of the term "hydro-aromatic" hydrocarbons. This term is still employed for cyclohexane and its simple derivatives, although its behavior is almost identical with that of normal hexane. The same applies to cyclopentane and its simple derivatives as compared with normal pentane, yet cyclopentane cannot be termed a "hydro-aromatic" hydrocarbon. Cycloheptane, cyclo-octane, cyclononane, cyclobutane, cyclopropane and ethylene should certainly be classed and described together with cyclohexane, as indeed Aschan and a few others have done. The differences in chemical properties between condensed ring systems of the benzene type and the non-condensed or *non-benzenoid* hydrocarbons are well established, but in spite of the enormous amount of work done, have not yet received adequate explanation.

It is a curious fact that during recent years a great part of the research in the field of the non-benzenoid hydrocarbons has been done in Russia, and most of this work has been very imperfectly abstracted, mostly through German publications. It is difficult indeed to estimate what may be the fate of scientific research in that unfortunate country during the next generation, and it seems worth while therefore to call attention to this relatively neglected field of research.

As regards the aliphatic hydrocarbons proper, these fare very badly in most works on organic chemistry, particularly the briefer textbooks. Usually, the entirely erroneous statement, or implication, is made that the so-called type reactions given for the first two or three members of the methane series hold good for the higher members. Beyond the fact that all of them may be completely burned to carbon dioxide and water, such statements are hardly in accord with the known facts.

WELL DEVELOPED SECTIONS OF ORGANIC CHEMISTRY

The chemistry of the aliphatic and alicyclic series of hydrocarbons may conveniently be classified into certain special chapters, the chemistry of which has in most cases been greatly extended and generally well surveyed. Thus the fatty acids and the chemical technology of the fats and fatty oils; the sugars, starches and celluloses; the amino acids and polypeptides; and the simpler alcohols and the chemical technology of alcoholic fermentation, represent comparatively sharply defined subjects, our knowledge of which is constantly being systematically extended by specialists in these fields of work. When we turn, however, to the non-condensed or non-benzenoid hydrocarbons and their simpler derivatives, we note that the chemistry of the first five members of the methane series and also the ten-carbon-atom or terpene group, mostly cyclic hydrocarbons, have been much more extensively and carefully studied than the remainder. Some of the reasons for this are fairly apparent. Thus, the essential oils afford a convenient source of substances of the terpene group which may generally be isolated easily in a state of purity. The natural fatty glycerides or other convenient sources readily yield a limited number of fatty acids, nearly all of them normal, i.e., acids of one, two, three, four, five, six, eight, ten, twelve, fourteen, sixteen, eighteen and twenty-four carbon atoms. Research in many of these special fields has accordingly been greatly facilitated by the availability of suitable material and has often been much stimulated by an intimate relation to industry.

It may also be pointed out that while in the aromatic series a rich variety of raw materials is easily isolated or prepared, crystalline derivatives are almost the rule, permitting easy purification, identification and manipulation in small quantities; that substitutive reactions are usually capable of control to form chiefly one product or a very limited number of products or isomers; but in the aliphatic series this is not the case. Petroleums probably contain all of the normal paraffine hydrocarbons up to $C_{28}H_{34}$ and perhaps farther in the series, and also most of the more stable naphthenes which are theoretically possible but for the most part yet unknown. Not only is it at present impossible to isolate individual substances from this complex raw material, but methods of synthesis applicable to the higher members have not yet been developed.

Probably the most careful work on the separation of the hydrocarbons by fractional distillation of hydrocarbons has been done by Young and his co-workers. They have shown that in the case of a mixture containing only pentane and isopentane, boiling points 36.3 and 27.9 deg. respectively, no less than thirteen carefully conducted fractional distillations, using a very efficient column, were necessary to effect separation of these two substances in a fair degree of purity. It is extremely probable therefore that most of the older work reporting the isolation of a great number of hydrocarbons from petroleum is entirely erroneous, and that the laborious distillation of petroleum fractions—for example, the "isolation" of a fraction boiling at say 212 to 216 deg. and calling it dodecane on the basis

of an analysis agreeing approximately with the formula C_nH_{2n+2} or $C_{12}H_{26}$—is nothing more or less than a lamentable waste of time.

Limit of Applicability of Certain Type Reactions

Most textbooks of organic chemistry give a number of type reactions which have a certain preparative value in the group methane to pentane inclusive. These reactions are usually briefly stated without any qualifications, even when the reactions as written represent only 10 per cent of the total result. Alkyl iodides are often preferred in reaction writing, probably for the reason that some early writer started the custom, although as Nef has shown for the ether reaction

$$RONa + R_1X \rightarrow ROR_1 + NaX$$

iodides give much poorer yields than bromides or chlorides and that the amyl iodides give olefines practically quantitatively (and this undoubtedly holds for the higher alkyl iodides). The Williamson synthesis has not been successfully carried out with alkyl halides containing more than eight carbon atoms, and nearly all of the amyl, hexyl, heptyl and octyl ethers now supposedly known were described in a single paper and this work has apparently not been repeated. It may also be pointed out that the sulphuric-acid method commonly used in preparing ethyl ether is not applicable to alcohols above butyl in the series.

The Grignard reaction has been a most valuable method of synthesis, yet this reaction also is practically valueless for alkyl halides containing more than six carbon atoms. As pointed out by Grignard and others, the higher alkyl halides not only react very slowly with magnesium but the principal reaction which does take place is the following:

$$RMgX + RX \rightarrow R\text{–}R + MgX_2$$

Thus a bromo hexane will give $C_{12}H_{26}$ almost exclusively.

$$C_6H_{13}MgBr + C_6H_{13}Br \rightarrow C_{12}H_{26} + MgBr_2$$

The above examples are cited in protest against the all too common practice of describing reactions applicable to ethane derivatives as type reactions of the whole aliphatic series.

Instability of the Alkyl Halides

Many of the familiar reactions which fail with the derivatives of the higher paraffines do so on account of the instability of the alkyl halides. Most of the methods of preparing alcohols fail with the higher alcohols, and the most useful method is that of Bouveault and Blanc, i.e., reduction of the ethyl esters of the fatty acids by metallic sodium in absolute alcohol, which method is therefore practically limited to the natural fatty acids. (Conversion of the natural fatty acids of an even number of carbon atoms to acids of odd number of carbon atoms is effected only with some difficulty by Krafft's method or through the α-bromo acids or the amides.) According to some very early work, apparently not since confirmed or extended, the condensation of the higher alkyl halides by metallic sodium to hydrocarbons and sodium halides

$$2C_{10}H_{21}X + 2Na \rightarrow C_{20}H_{42} + 2NaX$$

proceeds with much better yields in the case of the higher alkyl halides than with the simpler members. Judging from the work of Nef on ether formation, the chlorides should give much better yields than bromides or iodides.

A property of the higher alkyl halides which does not appear to have been carefully investigated is their reaction with alkali cyanides, hydroxides, sodium malonic ester, aniline, quinoline, etc., to give in part saturated hydrocarbons. With sodium cyanide, for example, one would expect largely olefine and a little alkyl cyanide or nitrile; with caustic alkali one would expect olefine and a little ether. But ring formation occurs to a considerable extent, with the elimination of halogen acid from two carbon atoms which may be near each other in space, as

$$\begin{array}{l} CH_2CH_2CHH{-}R \\ | \\ CH_2CH_2CH_2Br \end{array} \rightarrow \begin{array}{l} CH_2CH_2CH{-}R \\ |\qquad\quad\;\; | \\ CH_2CH_2CH_2 \end{array} + HBr$$

analogous to the formation of the cyclo propane ring by elimination of HBr from bromodimethyl glutaric ester (Perkin and Thorpe, *J. Chem. Soc.*, vol. 75, p. 48) and the reaction

$$CH_3COCH_2CH_2CH_2Br + NaOH \rightarrow \begin{array}{c} CH_3COCH{-}{-}{-}CH_2 \\ \diagdown\;\;\diagup \\ CH_2 \end{array}$$

observed by Lipp (*Ber.*, vol. 22, p. 1,207).

Influence of Adjacent Radicles

The properties of the ethylene bond present an array of incompletely solved problems. Here again the briefer textbooks of organic chemistry usually present a number of type reactions without qualifications, whereas it is not too much to say that the properties of the ethylene bond depend very largely upon the character of the groups or atoms adjacent or near to it.

Thiele's well-known theory of partial valence attempted to account for many observed peculiarities of conjugated double linkings. The addition of halogens, particularly bromine, to olefines is commonly stated to be a characteristic reaction, but it should be pointed out that there is probably every gradation in speed of reaction between bromine and substituted ethylenes, from ethylene and propylene which combine with bromine at —80 deg. with a velocity too great to be experimentally measured (Plotnikov), to the substituted ethylenes containing several strongly electro-negative groups, studied by Bauer (*Ber.*, vol. 37, p. 3,317; 1904), which are entirely inert to bromine. Reactions which are less energetic than the addition of bromine are often markedly affected by minor structural differences. One case in which advantage is taken of such behavior is in the manufacture of isoprene from normal pentane by one of the Badische processes. The process yields a mixture of normal and iso amylenes. On treating with HCl the latter reacts only with the amylene

$$\begin{array}{l} CH_3 \\ CH_3 \end{array}\!\!\!> C{=}CH.CH_3 + HCl \rightarrow \begin{array}{l} CH_3 \\ CH_3 \end{array}\!\!\!> CCl.CH_2CH_3$$

and this reaction product may then be separated by distillation and the unchanged amylenes put through the isomerizing process again.

The addition of water to olefines by means of aqueous sulphuric acid has heretofore been assumed to take place exclusively through the hydrolysis of alkyl sulphuric esters,

$$\begin{array}{l} R\,CH \\ \| \\ R_1CH \end{array} \rightarrow \begin{array}{l} R\,CH_2 \\ | \\ R_1CHOSO_3H \end{array} + H_2O \rightarrow \begin{array}{l} R\,CH_2 \\ | \\ R_1CHOH \end{array} + H_2SO_4.$$

This reaction is best carried out in the cold and the alcohol is separated by pouring into ice water, yet the

alkyl sulphuric esters made by the action of sulphuric acid on alcohols are not appreciably hydrolyzed by water at 0 deg. Other evidence also points to the possibility that hydration of olefines by aqueous sulphuric acid is due to the intermediate formation of unstable esters of ortho sulphuric acid $H_2SO_4H_2O$ or

$$\begin{matrix}HO\\HO\end{matrix}\!>\!\underset{\underset{O}{\|}}{S}\!<\!\begin{matrix}OH\\OH\end{matrix}$$

An American petroleum company has recently undertaken the manufacture of a series of the simpler secondary and tertiary alcohols from petroleum or oil gas olefines. In connection with the addition of water to olefines by aqueous sulphuric acid, it may be recalled that in a few instances water alone will react with the double bond, as with the ketenes $(R)_2C{=}CO$. Also the remarkable reactivity of the olefine bond in the group $-CH{=}CH{-}C{=}O-$ has been the subject of considerable research and speculation. Substances containing this group are often easily "hydrolyzed" by dilute acids with rupture of the carbon chain, e.g., mesityl oxide, citral, pulegone, etc. The extreme reactivity is also shown by their ability to combine directly with a wide variety of substances. The addition of sodium acid sulphite to carvone, citral, citronellal and the like to give stable sodium sulphonates of the type

$$\begin{matrix}-CH\\ \|\\ CH\\ |\\ CO\\ |\end{matrix}\quad\longrightarrow\quad\begin{matrix}-CH_2\\ |\\ CH\text{-}SO_3Na\\ |\\ CO\\ |\end{matrix}$$

is well known, but the addition of malonic ester, aceto acetic ester and hydrocyanic acid to olefines of this type is perhaps not so well known. It may be of interest to note that the group $-CH{=}CH.CO-$ is also necessary to the perfume value of many substances, for example ionone.

Polymerization

One of the most common and yet obscure properties of olefines is their tendency to polymerize. Conjugated diolefines possess this property to a high degree, as is now well known through the researches on the preparation of synthetic rubbers from butadiene, isoprene and dimethyl butadiene. Very few simple cases of polymerization have been studied, but Kondakow (*J. prakt. Chem.*, N. F. 54, p. 447; 1896) showed that di-isobutylene possesses the constitution indicated in the following:

$$2\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!C{=}CH_2\longrightarrow\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!\underset{\underset{CH_3}{|}}{C}\text{-}CH{=}C\!<\!\begin{matrix}CH_3\\CH_3\end{matrix}$$

Such polymerization may be effected by a wide variety of substances. In the case of concentrated sulphuric acid, which is known to form alkyl sulphuric esters at least in part, it is not difficult to construct a theory by which such changes may be accounted for. But the mechanism of polymerization under the influence of metallic sodium, heat and light is not so easy—in fact it is entirely obscure. The mechanism of the polymerization of hydrocarbons is undoubtedly intimately connected with the fundamental properties of molecules and our theories of valence. Further information regarding the effect of heat and light on the vibration or "loosening" of the valency electrons will undoubtedly go far to explain the polymerization of olefines, as well as the shift in position of double bonds which is so frequently observed to occur.

Instability of Molecular Structure

Mobility or instability of the carbon atom structure is one of the most striking properties of non-benzenoid substances. Thus isobutyl alcohol and the primary isobutyl halides yield a mixture of butylenes which has been shown to contain isobutylene and α and β normal butylenes.

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!CH.CH_2X\longrightarrow\left\{\begin{matrix}\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!C{=}CH_2\\ CH_3CH{=}CH.CH_3\\ CH_3CH_2CH{=}CH_2\end{matrix}\right.$$

Nef believed such facts could be best explained by the intermediate formation of a cyclopropane ring, which structure is known to be easily ruptured.

$$\underset{\underset{CH_2H}{|}}{CH_3\text{-}CH\text{-}CH_2X}\longrightarrow\underset{\underset{CH_2H}{|}}{CH_3\text{-}CH\text{-}CH}\!<\longrightarrow\underset{\underset{CH_2}{|}}{CH_3\text{-}CH{-}CH_2}$$

$$\longrightarrow CH_3\underset{|}{C}H\text{-}CH_2\text{-}\underset{|}{C}H_2\longrightarrow\left\{\begin{matrix}CH_3CH{=}CHCH_3\\CH_3CH_2CH\;CH_2\end{matrix}\right.$$

A similar example has been reported by Tissier (*Ann. Chim. Phys.*, Ser. 6, vol. 29, p. 361.)

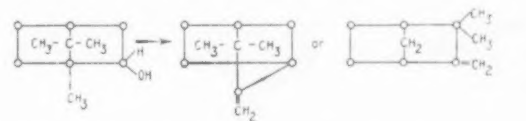
$$\underset{\underset{CH_2H}{|}}{(CH_3)_2C\text{-}CH_2Br}\longrightarrow(CH_3)_2C{=}CH.CH_3$$

and another by Coutourier (*Ann. Chim. Phys.*, Ser. 6, vol. 26, p. 464).

$$\underset{\underset{CH_2H}{|}}{(CH_3)_2C\text{-}CHBr\text{-}CH_3}\longrightarrow(CH_3)_2C{=}C\!<\!\begin{matrix}CH_3\\CH_3\end{matrix}$$

Other well-authenticated and striking changes in structure occur in the cyclic series, the change of the six carbon ring to the seven carbon ring, the change of the six carbon ring to the five carbon ring and vice versa and particularly the series of such cases recently studied by Meerwein (*Ann. Chemie*, vol. 376, p. 152, 1910; vol. 405, p. 129, 1914; vol. 417, p. 255, 1918) in his study of camphene and the borneols. Thus Meerwein has proved that 1.1 methyl α oxethyl cyclopentane on dehydration yields dimethyl cyclohexene

analogous to the structural changes in the formation of camphene from isoborneol by loss of water



Probably the best known type of molecular rearrangement, in the aliphatic series, is the pinacone-pinacoline conversion. But many similar rearrangements fall outside this class, for example

$$\begin{matrix}CH_3\\CH_3\\CH_3\end{matrix}\!\!>\!\underset{\underset{Br}{|}}{C\text{-}CH}\text{-}CH_3\longrightarrow\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!C{=}C\!<\!\begin{matrix}CH_3\\CH_3\end{matrix}+HBr$$

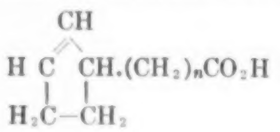
to which Tiffeneau refers as "retropinacoline rearrangements." Meerwein has recently made a systematic study of pinacones in an effort to determine the relative ease

of "migration" of different groups. So far our knowledge of these molecular rearrangements is little more than a catalogue of the facts, but it is probably not rash to hazard the opinion that our next real advance in our understanding of these facts will come not from organic chemists but from those physical chemists who are investigating atomic structures and valence.

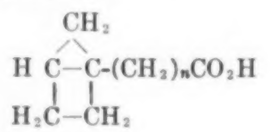
Field for Industrial Research

There are innumerable definite subjects for investigation which would be of industrial interest and possibly valuable. Good methods for the synthesis of the higher alcohols and aldehydes are lacking. No satisfactory method for the synthesis of menthol has been developed, although the hydrocarbon paramenthane can be readily made by the hydrogenation of paracymene. We are apparently on the threshold of the chemical utilization of the simpler olefines, particularly ethylene and propylene. Large-scale development work recently carried out indicates that ethyl alcohol, acetaldehyde, acetone, glycols, chlorhydrins and chlorinated solvents will be manufactured on a large scale, probably from oil gas. The possible uses in syntheses of the reactive chlorhydrins and the corresponding oxides, such as ethylene oxide, propylene oxide, amylene oxide and the like, are many.

Petroleums offer an enormous, though difficult, field for industrial research, but the utilization of petroleum hydrocarbons in chemical ways has undoubtedly been held in check by our lack of knowledge of the non-benzenoid hydrocarbons generally. As regards the origin of petroleums it is of interest to note the recent finding of a highly unsaturated hydrocarbon, $C_{29}H_{48}F_{6}$ in shark liver oils. It is now fairly well established that the naphthenic acids of Russian petroleum are derivatives of cyclopentane, and Power and Barrowcliff have found similar acids in certain vegetable oils. They conclude that the optically active acids of chaulmoogra oil are also derivatives of cyclopentane,



or



Formation of Petroleum

Although Engler has shown that the destructive distillation of fats or fatty oils under pressure yields a mixture composed chiefly of hydrocarbons and closely resembling crude petroleum, this by no means proves that petroleums were formed in this manner. Petroleums are sometimes found trapped in undisturbed strata, free from volcanic intrusions or other source of heat, as in the Trenton limestone in Ohio, but proponents of the Engler theory state that during the long periods of geologic time these same changes may occur at much lower temperatures than those employed experimentally by Engler, a proposition naturally incapable of proof or disproof. It should be pointed out, however, that we are entirely in the dark as to how saturated hydrocarbons are formed by biochemical processes in nature—for example, normal heptane in the oleoresin of *Pinus sabiniana*, and paraffines in many essential oils, as in the common rose.

Unsaturated hydrocarbons, such as the terpenes, are conceivably formed by decomposition of terpene alcohols, which can be duplicated in many cases *ex vitro* by treating with organic acids, formic or oxalic, at very moderate temperatures. Some have claimed that anaërobic fermentations, such as would doubtless occur in organic remains under water and mud and which is commonly observed in the decomposition of cellulose to methane, furnish us with the most plausible theory of the origin of petroleum. Certain micro-organisms build up complex waxy substances, as for example the tubercle bacillus, and Reichenbach first recognized paraffine as one of the products of decomposition of organic matter. As has been pointed out by Maberry, the action of sulphur and air, or oxygen, on petroleums has probably modified them to a great extent.

As regards sulphur, Erdmann has recently shown that this element combines directly with olefines, apparently as S_3, forming what Erdmann terms thiozonides. Beyond this we know only that when strongly heated together, sulphur and heavy hydrocarbons give hydrogen sulphide and tar or coke. Friedmann's attempt to form benzene and toluene by removing hydrogen from cyclohexanes by heating with sulphur was negative. The structure of the well-known and valuable ichthyols is not known, but products closely resembling the natural Austrian ichthyol have been manufactured in this country since the Austrian supply was cut off in 1914.

Fatty Acids and Asphalts From Paraffine

The oxidation of paraffines and the non-benzenoid hydrocarbons generally by air or oxygen has been studied but little. Byerly developed his well-known process of manufacturing asphalt by air blowing the heavy petroleum residuum, and this process is apparently catalyzed by small quantities of sulphur. In this process water is formed and the product contains very little oxygen, but recent work indicates that true fatty acids can be made by the air oxidation of paraffine at about 150 deg. The latter process has probably been inspired by the desirability of manufacturing fatty acids from petroleum hydrocarbons. It is of course possible that some empirical method may be stumbled upon which will serve as a manufacturing process, but a problem of this magnitude deserves careful research of the highest order.

Unsaturated Hydrocarbons

In connection with the oxidation of saturated hydrocarbons the problem of utilizing the unsaturated hydrocarbons of petroleum distillates should be mentioned. At the present time these substances are largely lost by the present refining methods, treating with concentrated sulphuric acid, etc. With the advent of shale distillation, which is bound to become of increasing importance as the supply of natural crude petroleum dwindles, the solution of this problem will become of increasing importance. For most purposes of lubrication it is, in the opinion of some, not necessary to remove the olefines and it is established through the work of Dunston and Thole and others that olefines possess somewhat greater viscosities than the corresponding saturated hydrocarbons. Hydrogenation of such material is technically very difficult on account of the poisoning of the catalyst by sulphur, always present in such oils. It is more likely that research will indicate a method of converting these olefines into other and valuable products which can be removed from the remaining saturated hydrocarbons. They are much more readily oxidized than saturated hydrocarbons, and it is possible that the solu-

tion of the economic production of fatty acids may lie in this direction. The chlorhydrins and glycols of the higher boiling olefines have not been prepared, probably for the reason that very few of such olefines are known or have been synthesized or isolated in a pure state. The glycols would undoubtedly be solid waxes possessing valuable properties. It is fairly obvious that a great deal of careful research on pure substances is needed to further our knowledge of these hydrocarbons, such work to proceed hand in hand with, or in advance of, the industrial developments, which procedure has yielded such fruitful results in the special field of the terpenes, essential oils and camphors.

Finally, it may be pointed out that there is no collected chemical literature published which brings the chemistry of the non-benzenoid hydrocarbons together in a systematic way and in such a manner as a student may easily study it. There are a number of very excellent works on the terpenes, the largest of which, Semmler's "Die Aetherische Oele," is about eighteen years out of date. The same may be said of Aschan's "Chemie der Alicyclische Verbindungen." Both of these works are also limited to the fields indicated by their titles. Vol. I of Engler's "Das Erdöl" is largely a catalog of the hydrocarbons noted by Beilstein, and their physical properties and more important chemical properties are briefly noted. Much valuable and up-to-date material is found scattered in several lesser works, such as E. J. Parry's "Essential Oils," Gurwitsch's "Wissenschaftliche Grundlagen der Erdölbearbeitung," Gildemeister's "Aetherische Oele," Meyer and Jacobson's famous "Lehrbuch" and the like. The compilation of a volume such as that of Aschan, including the open chain hydrocarbons as well as the cyclic ones, and brought up to date would undoubtedly facilitate and induce further research and the development of new experimental methods in this field, which in some directions is comparatively neglected but potentially most rich.

British Officials to Visit Industrial Centers

The British Department of Overseas Trade has completed arrangements for the periodical dispatch of certain of its officers having specialized knowledge of particular trades to the important industrial centers of the United Kingdom in order to bring the department into direct contact with the provincial firms. The co-operation of the Association of British Chambers of Commerce and, through it, that of the local chambers of commerce have been secured.

It is planned that the visits shall be monthly and cover in each case about five days. Publicity will be given in advance of the proposed visits of officers, and provincial firms desiring an interview are expected to make application to the Chamber of Commerce in the most suitable center. The visiting officers will deal with problems connected with overseas trade possibilities and conditions and discuss as far as possible such matters as:

1. Contracts open to tender.
2. Overseas demand for particular goods.
3. Importers of various goods in overseas markets.
4. Agencies for British manufacturers.
5. General conditions obtaining in overseas markets, including:
   - (*a*) Best method of marketing and distribution.
   - (*b*) Credit conditions.
   - (*c*) Terms of payment.
   - (*d*) Nature of competition and best methods of meeting same, etc.
6. Shipping and transport.

Development of Kauri-Gum Industry in New Zealand

Since the close of war more attention has been given to the development of the kauri-gum industry in New Zealand than any time during the past five years, with the result that it seems probable that greater quantities of kauri gum and its byproducts will be produced than heretofore.

Oil From Kauri Peat Swamps

There are very extensive kauri-peat swamps in New Zealand that have been placed at the disposal of interested parties by the New Zealand Government on a leased basis. The present area which the Governor General by Order in Council may set apart for the development of this industry is 10,000 acres which may be leased for forty-two years, with no party to receive a lease exceeding 3,000 acres. The lessees have to pay a low rental and also a royalty on kauri oil and other valuable products obtained.

The New Zealand Peat Oils (Ltd.) has taken one grant of 3,000 acres, and is now developing it with reasonably good prospects of success, having tested four samples taken from different depths of the swamp which yielded an average of 29 gal. of crude kauri-gum oil to the ton, with a yield of 4,300 cu.ft. of gas per ton. This company proposes to push the development of this industry during the coming year.

Kauri-Gum Extraction and Grading

A new method of gathering and grading kauri gum has lately been undertaken, whereby kauri-peat swamps that are thoroughly pregnated with kauri gum in different stages of decomposition can be worked with reasonably good success, according to late reports. It is claimed that if this process succeeds, as indicated at present, there can be more kauri gum secured from the deposits in the North Island than has been secured to date, though of an inferior grade to that which has been gathered.

It is proposed to sort this kauri gum into about three or four grades according to size, which means largely according to the degree of decomposition. It is claimed any grade would be sufficient in quality for the manufacture of the lower grades of varnishes and similar products, and would be exceptionally good for the manufacture of linoleums and that line of goods and it is expected that these qualities of kauri gum can be produced in such quantities as to be sold for a very much more reasonable price.

Production of Kauri Gum

The production of kauri gum during the seven years previous to the beginning of the war averaged not far from 8,000 tons per year, while since that time it has scarcely averaged 4,000 tons, and during the year ended March 31, 1919, amounted to only 2,338 tons. Of the output of 8,473 tons for 1914 the United States took 4,531 tons, the United Kingdom 3,335 tons, Germany 373 tons, and the remainder was well scattered over ten other countries; while for the year ended March 31, 1919, the United States took 1,371 tons of the 2,338 tons, the United Kingdom 346 tons, Canada 572 tons, and Australia 49 tons.

Of late quite large quantities of kauri gum have been going forward to the United States as shipping space could be obtained, and there are still large quantities in hand for export.

The Chemistry of Leather Manufacture*

By Dr. James A. Wilson

THE leather business is a chemical industry, but has not been developed by chemists, although dating back to ancient times. It has been only in the last thirty-five years that the chemist has in any way been connected with the operations of leather manufacture. Up until five years ago he was called in only to settle disputes between the buyer and seller on the various chemicals purchased for the business. This condition still exists in a great many tanneries.

The chemist has not altered the fundamental principles of the industry. but he has improved upon the processes, and it may be predicted that within the next few years he will do much to change the operation entirely. There are no up-to-date books published at the present time on this branch of the industry.

Consecutive Stages in the Treatment of Hides at the Tannery

Hides are received at the tannery in four conditions—namely, fresh, salted, and dried hides, and hides that have been both salted and dried. The first operation is to soak the skins in water to remove dirt and blood and at the same time swell the fibers to a normal condition. When the hides are removed from these soaks, which require from four to five days, they contain about 80 per cent water.

They are then taken to the beam house, where everything is to be removed except the hide fibers and grain. The main mass of the hide consists of fibers with an epidermal layer containing the hair on one side. Beneath this epidermal layer is a second layer which contains the roots of the hair. In order to free the hide from hair it is soaked in a solution of lime in excess with sodium sulphide. Addition of sodium sulphide in the lime water cuts down the time of dehairing from two weeks to from one to three days. This alkali destroys the under layer of skin which holds the hair, so that when the hide is taken from the bath it may be easily brushed free by hand. The chemistry involved in this operation is supposed to be the hydrolysis of the under layer of skin. The hide fibers swell further during this process and after the hair has been scraped off and all extraneous substance removed, it is taken to the bating house. The old method of bating consisted of soaking in dung, but this has been displaced by the use of so-called bates—mixtures of sodium chloride and trypsin. While soaking in this solution the swelling caused by liming is somewhat counteracted.

Chemical Action in Tanning by the Chrome Method

If the leather is to be tanned by the chrome method a mixture of hydrochloric and sulphuric acid is added to acidify the hide before it goes to the $CrOHSO_4$ solution. This acidification is to prevent any precipitation in the chrome bath. Chemical control is exercised during this pickling process.

In chroming leather, the basicity and the chromium concentration must be correct. By far the most important factor is the content of neutral salts, that is, of ammonium chloride, lithium chloride, magnesium chloride or sodium chloride. The real chemical action consists of the formation of a chromium collagenate in the leather, by reaction between the tannin and hydroxyl group, and the resulting substance may be considered as an analogous compound to chromium acetate. If too large a quantity of the neutral salt is present, the quantity of solvent is reduced because of the hydration of this salt, which thus increases the per cent of all constituents present in solution. The test for the end of this reaction is made by placing a piece of the leather in water and boiling for five minutes, during which time no change can take place in the general visual appearance.

Vegetable Tanning

In vegetable tanning no acid or pickling bath is used, the chemical action being a combination between tannin and the amino group. One of the common tanning materials is hemlock liquor, prepared by extracting hemlock bark with water. The hide first goes through a weak solution of this liquor and gradually moves forward to solutions of increasing strength and astringency. This may be done either by changing the hide from vat to vat or by pumping in stronger liquors each time.

Of all the vegetable tanning extracts available, quebracho—secured from South America—is cheapest, most plentiful and gives excellent weight to the hide, and would ordinarily be used where the finished product is to be sold by weight. It is considered by many tanners that quebracho bark cannot be used alone in tanning because of its high astringency and that the first steps of the process must be accomplished with gambier or sumac. Experiments made by the speaker showed, however, that quebracho extract can be used without resorting to the other more expensive extracts by simply diluting with gallic acid or similar diluent.

Oiling the Hides

After the leather is tanned, either by the chrome or vegetable process, oil must be incorporated into the hides to make them pliable and tough. This is usually done by treating them with an emulsion of hot oil and water in a process called "drumming," during which the oil is taken into the hide and water forced out. This operation requires only from ten to fifteen minutes. In case of some of the heavier leathers heavy grease is rubbed into the hides. About 6 per cent of oil by weight is absorbed in the light leathers and as high as 20 per cent in the heavier leathers where the grease treatment is used. Mineral oil is necessary during the drumming operation to dissolve the solid fatty acids from the hide, while vegetable oil is necessary because it does not leave grease on the surface of finished leather. Thus a proper mixture of both is necessary to successful operation.

Microphotographs of finished leather sections show that the substance is a fibrous material. The animal source of a particular finished leather can easily be detected by magnifying a sample to ten diameters, each different kind of hide showing a distinctive appearance.

Leather chemists have much in common with the scientists at the universities, and need the co-operation of both physicists and chemists in the development of their industry. Many problems can be made available to the research department of any university desiring to enter into the subject.

*Abstracts of remarks presented at the Chicago Section meeting, American Chemical Society, April 23, 1920.

A Comparative Test Upon High-Speed Steels—III

A Detailed Description of the Method of Procedure in Testing Sixteen Different Commercial Brands of High-Speed Tool Steel, Together With Data as to the Performance of Each Individual Tool, Its Chemical Composition, Heat Treatment, and Hardness*

BY A. J. LANGHAMMER, M.E.†

VARIOUS steps in the preparation for a test are fundamentally important and must be carefully planned and performed to insure ultimately correct data. The essential factors are composed of the following steps, each one of which will be briefly described: First, procuring specimen bar of high-speed steel; second, making of tool; third, heat treatment of tool; fourth, grinding of tool; fifth, apparatus used and working details, and sixth, chemical and metallographic tests.

PROCURING SPECIMEN BAR OF HIGH-SPEED STEEL

A small order specifying the "best grade" of high-speed steel was placed with the various steel manufacturers. No mention was made of the fact that this steel was to be used for test purposes. A reasonably short time for delivery was specified. Upon receipt of shipment, each item was held for the personal attention of the man in charge of the test. After general physical inspection every bar was duly labeled and carefully stored until all the steel ordered had been received.

MAKING OF TOOL AND HEAT TREATMENT

A short piece was cut by a power hack saw (not nicked and broken) from the end of each bar and the latter then inspected at the "cut." Hereupon another piece was cut off for chemical and metallographical investigation. Finally, four pieces, each 6 in. in length, were cut for the test tools proper. Every tool was at once marked permanently with a symbol (A, B, etc.) representing the brand of steel and then stamped number 0, 1, 2 or 3 to differentiate among the tools of the brand. This designation was adhered to throughout the test and provided positive means of identification at all times as well as a concise method for comparison. The symbols chosen, too, were of such nature that they did not directly reveal the brand of the steel, which practice provides for absolute impartiality on the part of the experimenters. All the tools were then machined on a milling machine to the dimensions and tool angles indicated[1] in Fig. 2, viz: 6 deg. clearance at the nose and 10 deg. at the heel, 14 deg. side slope, 0 deg. back slope, 32 deg. horizontal clearance and 8 deg. vertical clearance, 84 deg. lip angle, and 90 deg. cutting angle. A slight cut was also taken from the base to insure a perfect seat. After machining, the tools were rough-ground to insure a minimum of finish-grinding upon hardening. All tools were then subjected to complete inspection and necessary corrections made, whereupon they were ready for hardening.

Once the tools were "made," and then only, every steel manufacturer or his representative was advised that a test was being conducted and they were given the choice of either hardening the tools themselves, having our man harden the tools under their direction, or send in their specifications for heat treatment and permit us to do the hardening without their supervision. It was understood, of course, that in each case the hardening had to be done in our plant and under constant observation. In the majority of cases the second proposal was accepted, i.e., our tool hardener performed the work in accordance with the verbal instructions of the steel companies' experts. Each representative had our entire equipment at his disposal and while he was at work no rival steel man was present. Our equipment was quite complete and the needs of each agent were easily satisfied. Every man was told that the heat treatment was the only factor he could control and that but one test of four tools could be made. He was therefore duly cognizant of the great importance of his work and was perforce extremely careful. Complete observations were made as to the methods applied and the behavior of each tool carefully noted, especially while at the high heat. A separate data sheet and discussion of the different methods of heat treatment applied are given in Table II in conjunction with the summary of chemical analysis and reproduced herewith.

Two furnaces were employed, one for the low or preheat and the other for the high heat. In each case the temperatures were adjusted to the satisfaction of the steel men before the tools were put into the furnace. Semi-muffle type oil-fired furnaces were used.

GRINDING OF TOOL

It is generally conceded that probably more tools are spoiled through overheating in grinding than in any other way. As pointed out above under "Making of Tool," all tools were rough-machined and rough-ground before hardening, thereby reducing the chances for ruining in grinding. A high-grade tool grinder performed the work under constant supervision, and in this way the danger of overheating was minimized and the correct values of cutting angles assured. The machine used was a Taylor automatic tool grinder and particular care was exercised to see that the copious stream of cooling water provided was applied to the nose of the tool directly at the point of contact with the emery wheel. After the tools had been finish-ground, each one was inspected for flaws in the material and all cutting and clearance angles were checked. The base of each tool, in addition, was inspected for deformation, since a perfect seat in the holder is essential.

After the tools were put through the first run they were reground to the original design except that the radius at the nose of the tool was double that of the original value, i. e., $\frac{1}{16}$-in. radius on the first run and $\frac{1}{8}$-in. on the second run. Of course, in the regrind here was more chance for injuring the tools. It is felt, how-

*For Parts I and II, see CHEM. & MET. ENG., vol. 22, Nos. 18 and 19, May 5 and 12, 1920, pp. 829 and 889.

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[1]See CHEM. & MET. ENG., vol. 22, No. 19, May 12, 1920, p. 890.

TABLE II. COMPOSITION AND HEAT TREATMENTS OF TOOL STEELS TESTED

	Chemical Composition *							Heat Treatment				
Brand	Carbon	Tungsten	Vanadium	Nickel	Chromium	Cobalt	Uranium	Preheating	Hardening	Quenching Medium	Drawing Temperature	Remarks on Heat Treatment
A	0.79	12.8	1.74	0.10	3.78	None	None	All tools slowly preheated to 1550-1600 F.	The temperature in the hardening furnace was maintained at practically 2300 F. The tools were withdrawn and quenched when the condition of sweating was satisfactory to the expert representing the steel company which produced the brand being hardened.	Oil	1050	Cyanide on tip of tools during hardening.
B	0.64	16.9	0.92	0.10	2.42	None	None			Lead at 1050 F	1100	"B" tools withstood the high heat very well.
C	0.40	18.00	0.51	Tr.	3.53	None	0.11			Lead and kerosene.	1050	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in kerosene.
D	0.62	14.86	1.05	Tr.	3.59	None	0.10			Lead at 1050 F	1100	One-half of tool immersed in lead. Relatively short heat.
E	0.49	17.35	0.23	Tr.	2.78	None	0.14			Lead	1100	
F †	0.67	19.70	0.99	0.21	3.78	None	None			Oil and lead	1100	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in oil.
..	0.65	15.79	0.49	0.24	3.44	None	None			.....	.....	
G	0.62	18.26	0.75	Tr.	3.70	None	None			Oil	1050	
H	0.66	18.30	0.45	None	4.17	None	None			Lead at 1050 F	1075	
J	0.68	18.12	0.48	Tr.	2.63	None	0.10			Oil and lead	1050	Tools 0 and 3 were immersed half way in oil; then they were placed on the floor and thus drawn.
K	0.59	13.34	0.95	Tr.	3.64	None	0.15			Oil	10.75	
L	0.76	21.92	1.05	None	5.27	None	None			Lead at 1050 F	1050	
M	0.69	16.95	0.75	0.18	3.09	None	None			Oil and kerosene	1100	Tool 2 quenched in oil. Tools 0, 1 and 3 quenched in kerosene. "M" tools withstood the high heat very well.
N	0.66	13.55	2.20	0.10	3.59	None	None			Oil	1050	
O	0.67	13.50	0.99	0.20	4.30	None	None			Oil and lead	1100	For tool 0 only. Tools 1, 2 and 3 were not drawn.
P	0.38	15.27	0.05	0.20	2.85	None	0.14			Lead	1100	Blistered on heating.
R	0.65	17.08	0.58	0.20	2.78	None	0.10			Oil and lead	1075	Tools 0 and 2 were quenched in lead. Tools 1 and 3 were quenched in oil.
13, 14‡	0.75	11.12	2.10	0.32	5.13	None	None			.....	.....	

The samples for chemical analysis were obtained from the same section of the bar of which the tools were made.

The temperature of the lead bath used in quenching was maintained at a temperature of 1050 F. The tools were immersed in the molten metal for about 3 min., and then allowed to cool in the air.

* Phosphorus and sulphur below 0.04 per cent in all cases.
† The second analysis under F gives that of a second bar obtained subsequently.
‡ This steel was not tested, but its microstructure is shown in Figs. 13 and 14.

ever, that with the care and vigilance that was exercised, this possibility was eliminated.

APPARATUS USED AND WORKING DETAILS

As stated in a foregoing paragraph, the machine tool used was a new 8-in. Lo-Swing lathe, shown[2] in Fig. 3. The general set-up is shown[3] in Fig. 1. Attention is especially invited to the particularly rigid method that is used for holding and driving the work. It is also to be observed that the set-up included but one tool block and that the tool traveled from the point shown to the dome end of the cylinder. Fig. 4 shows[4] very clearly the method of clamping the tool and attention is called to the unusual area of tool base that is clamped and supported, as compared with the ordinary lathe tool post.

When each cut was started the tool was carefully "fed in" until the proper depth of cut (3/32 in.) was reached. The tool was then fed by hand longitudinally for about ¼ in. for the purpose of checking the "turned" diameter. In this way the depth of cut was held very close—within the limits of plus or minus 0.0025 in., to be exact. Only after the correct depth of cut had been attained was the longitudinal power feed engaged (0.054 in. for first run and 0.090 in. for second), the stop watch being started at the same time. As soon as the cut was "across," the watch was stopped and the time recorded. This was repeated until the tool failed, whereupon the total time or life of the tool was at once computed by the observer, which figure was later checked in the office. All other tools were then put through the test in the same way. Whenever a tool failed in cutting, the "burned" part of the cylinder that was caused by the tool failing was turned off with a tool that was not a test specimen, thereby relieving the succeeding test tool of the handicap of cutting metal hardened by burning. In this way every test tool started to cut under identical conditions, which was especially desirable in our case because of the relatively short length of the material cut.

As a further check on the life of each tool, the actual number of cylinders machined was recorded and then compared with the total time credited to the tool.

After the life of each tool was recorded and these data checked, the results were plotted and are shown in the graphical representation on "curve sheets," reproduced in Figs. 5 and 6. The time or life of each tool was plotted as abscissæ, while the brands were indicated as ordinates. In both runs the value representing the total life of each set of tools is shown on the same sheet. It will have been noticed that each individual tool was stamped with a symbol representing the particular brand from which it was made and that the tools in each brand were numbered 0, 1, 2 and 3. By using this differentiation and referring to the data sheets on chemical analysis, heat treatment, and the curve sheets, the why and wherefore of exhibited characteristics can usually be traced quite easily. To facilitate this work, however, a series of data sheets under "Notes on Performance" have been included below.

CHEMICAL AND METALLOGRAPHICAL TESTS

It has been pointed out that a short piece was cut from each bar of steel for the purpose of procuring the chemical analysis of each brand. The work was done in the Packard laboratory and as some of the data appeared questionable, check samples were sent to a local laboratory and again to New York, each report concurring in our analysis, except in the case of uranium. Both outside laboratories reported more than 0.20 per cent uranium in brand "D" but only a possible trace in half a dozen other brands.

Several microphotographs were made and will be published later with a separate discussion. In the same

[2]See CHEM & MET. ENG., vol. 22, No. 19, May 12, 1920, p. 891.
[3]See CHEM. & MET. ENG., vol. 22, No. 19, May 12, 1920, p. 889.
[4]See CHEM. & MET. ENG., vol. 22, No. 19, May 12, 1920, p. 891.

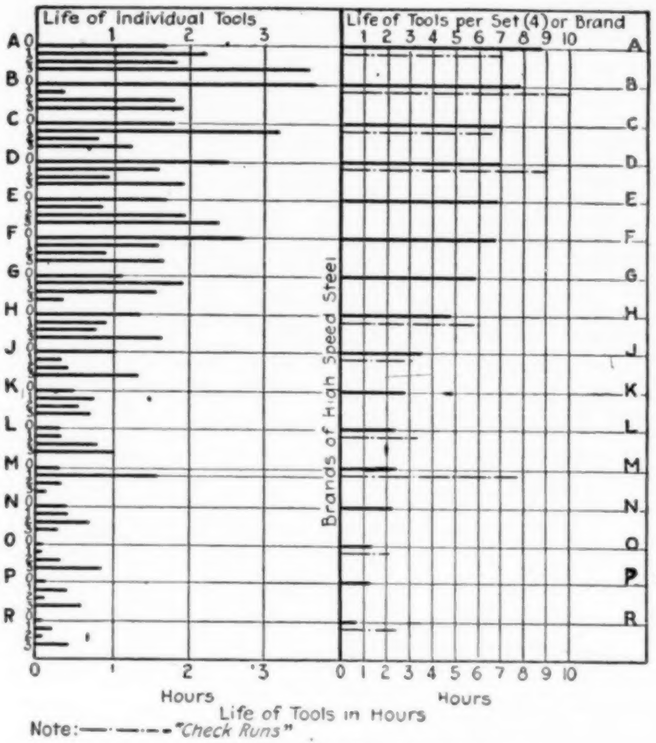


FIG. 5. CURVE SHEET OF FIRST RUN

Turning Liberty motor cylinders 5¼ in. diameter. Tool with 1/16-in. radius nose; cutting speed, 35 ft.; feed, 0.054 in.; depth, 3/32 in.

way, while Table II shows the chemical analysis, comments thereon will be given subsequently.

Table VII, giving the scleroscope hardness of each individual test tool, is included for checking purposes. It is contended that the degree of scleroscope hardness is in no way related to red-hardness, once a certain initial hardness (about 80) has been attained. In other words, if one tool registers 83 and another 88, it does not follow that there will be any difference in the cutting qualities of the two. Hardness readings should be taken of each tool after the finish grinding for the first run and used as a general indicator. The given data were secured at that time. The readings taken at the nose tip are, of course, lower in value than those of the group taken farther back on the lip surface. This is due to the fact that in the first instance the drop hammer rebounded from an overhung surface, while in the latter case the footing was solid, the heel being directly beneath the point where the reading was se-

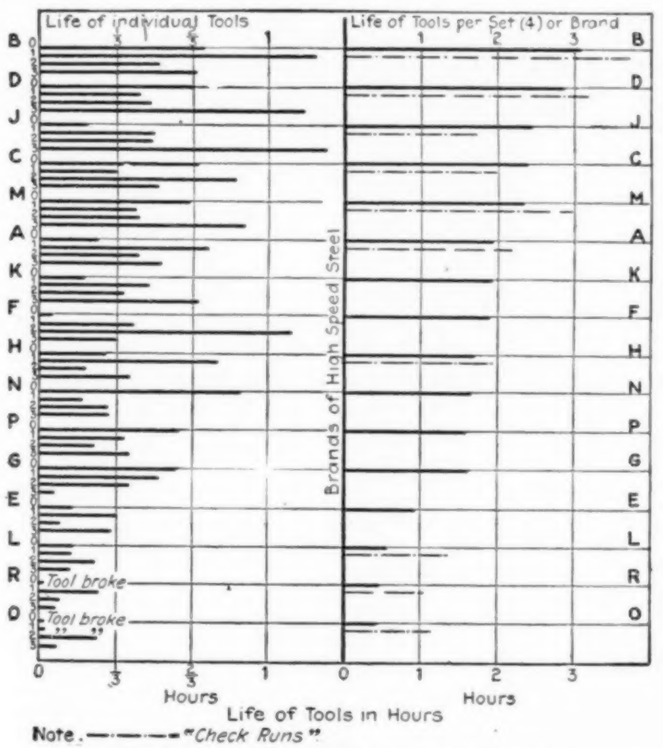


FIG. 6. CURVE SHEET OF SECOND RUN

Turning Liberty motor cylinders 5¼ in. diameter. Tool with 1/8-in. radius nose; cutting speed, 35 ft.; feed, 0.090 in.; depth 5/32 in.

TABLE IV. NOTES ON PERFORMANCE OF FIRST RUN

Brand	No.	Time	No. of Cylinders	Remarks
L	0	20.6 min.	4	Dulled quickly; then failed.
	1	20.5 min.	4	Dulled quickly; then failed.
	2	47.8 min.	9	Failed slowly.
	3	56.2 min.	11	Failed quickly.
		Total time, 2 hr. 25 min. 6 sec.		
C	0	1 hr. 48.0 min.	21	Showed wear early but continued to cut.
	1	3 hr. 12.9 min.	38	Failed rapidly.
	2	49.0 min.	10	Failed suddenly.
	3	1 hr. 17.3 min.	15	Showed wear early but continued to cut.
		Total time, 7 hr. 7 min. 12 sec.		
A	0	1 hr. 40.4 min.	20	Tool indicated wear and then failed.
	1	2 hr. 14.5 min.	27	Failed slowly.
	2	1 hr. 52 min. 42 sec.	22	Failed slowly.
	3	3 hr. 39 min. 18 sec.	44	Failed gradually.
		Total time, 9 hr. 26 min. 54 sec.		
B	0	3 hr. 40.5 min.	44	Failed very slowly.
	1	21.6 min.	4	Nose chipped.
	2	1 hr. 51.5 min.	22	Failed slowly.
	3	1 hr. 56.7 min.	23	Failed after showing dullness.
		Total time, 7 hr. 50 min. 18 sec.		
O	0	4.6 min.	1	Tool broke.
	1	2.1 min.	½	Tool broke.
	2	20.5 min.	4	Dulled quickly; then failed.
	3	52.2 min.	10	Failed suddenly.
		Total time, 1 hr. 19 min. 24 sec.		
M	0	19 min. 17 sec.	4	Showed chipped cutting edge.
	1	1 hr. 36 min. 6 sec.	19	Failed suddenly.
	2	20 min. 56 sec.	4	Showed slightly chipped cutting edge and failed quickly.
	3	7 min. 15 sec.	2	Failed quickly.
		Total time, 2 hr. 23 min. 34 sec.		
H	0	1 hr. 21 min. 30 sec.	16	Failed slowly.
	1	56.0 min.	11	Uniform wear.
	2	47.0 min.	9	Failed quickly.
	3	1 hr. 39 min. 38 sec.	20	Failed slowly.
		Total time, 4 hr. 44 min. 8 sec.		
K	0	31 min. 14 sec.	6	Dulled quickly.
	1	46 min. 49 sec.	9	Failed suddenly.
	2	34 min. 56 sec.	7	Nose chipped slightly but continued to cut.
	3	44 min. 14 sec.	9	Failed quickly.
		Total time, 2 hr. 37 min. 13 sec.		
J	0	1 hr. 6 min. 28 sec.	13	Failed slowly.
	1	19 min. 8 sec.	4	Dulled; then failed quickly.
	2	27 min. 36 sec.	5	Dulled; then failed rapidly.
	3	1 hr. 20 min. 5 sec.	16	Failed quickly.
		Total time, 3 hr. 13 min. 17 sec.		
D	0	2 hr. 29.0 min.	30	Failed slowly.
	1	1 hr 37.3 min.	19	Failed slowly.
	2	59.0 min.	12	Failed gradually.
	3	1 hr. 55.9 min.	23	Failed slowly.
		Total time, 7 hr. 1 min. 12 sec.		
P	0	4.2 min	1	Failed quickly.
	1	24.9 min.	5	Dulled early.
	2	6.4 min.	1	Failed quickly.
	3	36.0 min.	7	Failed suddenly.
		Total time, 1 hr. 11 min. 30 sec.		
N	0	23.0 min.	4	Dulled quickly but continued to cut.
	1	25.8 min.	5	Failed quickly.
	2	44.1 min.	9	Failed slowly.
	3	18.3 min.	4	Showed wear, then failed.
		Total time, 1 hr. 51 min. 12 sec.		
R	0	3.4 min.	1	Nose broke.
	1	9.8 min.	2	Failed quickly.
	2	0.8 min.	0	Failed quickly.
	3	27.3 min.	5	Failed gradually.
		Total time, 41 min. 18 sec.		
E	0	1 hr. 44.0 min.	21	Failed quickly.
	1	52.3 min.	10	Failed rather slowly.
	2	1 hr. 58.9 min.	24	Failed slowly.
	3	2 hr. 24.0 min.	29	Failed slowly.
		Total time, 6 hr. 59 min. 12 sec.		
F	0	2 hr. 45.8 min.	33	Failed slowly.
	1	1 hr. 36.3 min.	17	Chipped but continued to cut.
	2	55.5 min.	11	Failed quickly.
	3	1 hr. 38.8 min.	20	Showed wear early.
		Total time, 6 hr. 56 min. 24 sec.		
G	0	1 hr. 8.1 min.	14	Showed wear but continued to cut.
	1	1 hr. 55.6 min.	23	Failed slowly.
	2	1 hr. 33.1 min.	19	Cut roughly but held the size.
	3	19.3 min.	4	Failed quickly.
		Total time, 5 hr. 54 min. 6 sec.		

TABLE V. NOTES ON PERFORMANCE OF SECOND RUN

Brand	No.	Time	No. of Cylinders	Remarks
C	0	41 min 42 sec	10	After 30 min. 54 sec., rapid wearing was apparent though the tool continued to cut.
	1	19 min 13 sec	5	Failed suddenly.
	2	51 min 36 sec	12	Showed wear three minutes before failure occurred.
	3	33 min 12 sec	8	Failed gradually.
		Total time, 2 hr. 25 min. 43 sec.		
N	0	53 min 30 sec	14	Failed suddenly.
	1	11 min 24 sec	3	Showed wear after the second cylinder.
	2	18 min	4	Failed slowly.
	3	18 min 18 sec	5	Failed slowly.
		Total time, 1 hr. 41 min. 12 sec.		
E	0	9 min 12 sec	2	Tool indicated dullness and then broke.
	1	20 min 30 sec	5	Failed gradually.
	2	5 min 24 sec	1	Tool broke.
	3	19 min 48 sec	4	The nose chipped after 4½ min., but continued to cut, though irregular.
		Total time, 54 min. 54 sec.		
O	0		..	Broke on first run.
	1		..	Broke on first run.
	2	15 min 30 sec	4	Dulled quickly but continued cutting and then failed suddenly.
	3	4 min 30 sec	1	Tool broke.
		Total time, 20 min.		
M	0	38 min 30 sec	9	Failed very slowly.
	1	25 min 22 sec	6	Failed suddenly several minutes after showing wear.
	2	26 min	7	Tool broke.
	3	54 min	14	Failed suddenly.
		Total time, 2 hr. 22 min. 52 sec.		
P	0	37 min	9	Failed slowly.
	1	22.5 min	5	Failed rapidly after becoming dull.
	2	14 min	4	Failed suddenly.
	3	24 min 48 sec	6	Failed gradually after first indication of dullness.
		Total time, 1 hr. 38 min. 18 sec.		
G	0	36 min 18 sec	9	Showed wear 1 minute before it failed.
	1	32 min 18 sec	8	Failed gradually in last 3 minutes.
	2	24 min	6	Failed slowly.
	3	3 min 36 sec	1	Tool broke.
		Total time, 1 hr. 36 min. 12 sec.		
H	0	17 min 42 sec	4	Grew dull 4 minutes before failure.
	1	47 min 6 sec	9	Failed very slowly.
	2	12 min 54 sec	3	Began to dull on the second cylinder.
	3	24 min 36 sec	6	Failed suddenly.
		Total time, 1 hr. 42 min. 18 sec.		
A	0	15 min	4	Nose chipped slightly after seven minutes running, then failed gradually.
	1	44 min 12 sec	11	Failed very slowly after first indication of dullness.
	2	26 min 30 sec	6	Failed gradually in the last four minutes.
	3	31 min 6 sec	8	Gave indication of dullness eight minutes before failure.
		Total time, 1 hr. 56 min. 48 sec.		
L	0	8 min 36 sec	2	Dulled quickly, wear increasing rapidly until failure occurred.
	1	8 min 12 sec	2	Failed slowly.
	2	14 min 6 sec	4	Showed wear on second cylinder but failed slowly.
	3	7 min	2	Failed gradually after the cutting edges chipped slightly.
		Total time, 27 min. 54 sec.		
B	0	43 min	11	Failure extremely slow after showing initial dullness.
	1	1 hr 13 min	18	Failed suddenly.
	2	30 min 16 sec	8	Failed slowly.
	3	40 min 30 sec	10	Failed very slowly after first signs of dullness.
		Total time, 3 hr. 6 min. 46 sec.		
J	0	12 min 30 sec	3	The nose of the tool broke off while feeding across.
	1	30 min 48 sec	8	Failed rapidly after indicating wear.
	2	29 min 42 sec	7	Showed wear two minutes before failure occurred.
	3	1 hr 14 min	18	Gave no indication of wear, the nose of the tool breaking while the power feed was engaged.
		Total time, 2 hr. 27 min.		
R	0			Tool broke when feeding in by hand to the proper depth.
	1	15 min	4	Grew dull soon after the start.
	2	5 min	1	Failed rapidly.
	3	4 min 12 sec	1	Failed rapidly.
		Total time, 24 min. 12 sec.		

TABLE V. (Continued)

Brand	No.	Time	No. of Cylinders	Remarks
K	0	11 min 48 sec	3	Failed suddenly.
	1	28 min 48 sec	7	Became dull and failed within one minute.
	2	22 min 12 sec	6	Failed six minutes after the first signs of wear.
	3	42 min 30 sec	10	Failed very slowly.
		Total time, 1 hr. 43 min. 18 sec.		
D	0	47 min	12	Failed very slowly.
	1	26 min 42 sec	7	Failed very slowly.
	2	29 min 18 sec	7	Failed gradually.
	3	1 hr 10 min	17	Gave indication of wear 35 minutes before failure occurred. Almost impossible to ruin the tool as it continued to cut while at a high red heat.
		Total time, 2 hr. 53 min.		

A marked characteristic of this steel is the tendency to dull quickly but continue to cut. It is also very difficult to "burn," and cools quickly after the cut is finished.

Brand	No.	Time	No. of Cylinders	Remarks
F	0	2.4 min	1	Tool broke.
	1	25 min	6	The nose of the tool broke but continued to cut for ten minutes before failing.
	2	1 hr 7 min	17	The nose of the tool chipped after 15 minutes.
	3	20 min	4	Dulled quickly but continued to cut.
		Total time, 1 hr. 54 min. 24 sec.		

TABLE VI. RECAPITULATION OF TEST RESULTS

First Run							Second Run				
Brand	Total Time for Four Tools H.	Min.	Sec.	Average Time for One Tool H.	Min.		Brand	Total Time for Four Tools, Hr.	Min.	Sec.	Average Time for One Tool, Min.
A	9	26	54	2	21.7		B	3	6	46	46.6
B	7	50	18	1	57.5		D	2	53		43.2
C	7	7	12	1	46.8		J	2	27		36.7
D	7	1	12	1	45.3		C	2	25	43	36.4
E	6	59	12	1	44.8		M	2	22	52	35.7
F	6	56	24	1	44.1		A	1	56	48	29.2
G	5	54	6	1	28.5		K	1	43	18	25.8
H	4	44	8	1	11.0		F	1	54	24	28.6
J	3	13	17		48.3		H	1	42	18	25.5
K	2	37	13		39.3		N	1	41	12	25.3
L	2	25	6		36.2		P	1	38	18	24.[illegible]
M	2	23	34		35.9		G	1	36	12	24.0
N	1	51	12		27.8		E		54	54	13.7
O	1	19	24		19.8		L		37	54	9.5
P	1	11	30		17.9		R		24	12	6.0
R		41	18		10.2		O		20		5.0

TABLE VII. HARDNESS OF TEST TOOLS

Brand	No.	Scleroscope Reading At the Extreme Tip of the Nose	Scleroscope Reading ½ In. Back of Nose	Brand	No.	Scleroscope Reading At the Extreme Tip of the Nose	Scleroscope Reading ½ In. Back of Nose
J	0	70-75	80	H	0	68-70	82
	1	62-64	78		1	65-70	82
	2	65-68	82		2	65-70	77
	3	62-67	78		3	70-73	80
C	0	65-68	78	M	0	68-70	80
	1	65-70	80		1	65-70	80
	2	65-70	88		2	70-73	85
	3	65-70	78		3	70-72	87
A	0	68-70	82	L	0	70-75	85
	1	73-75	82		1	70-75	82
	2	65-70	82		2	68-70	75
	3	65-70	85		3	70-72	82
R	0	70-72	85	B	0	65-70	78
	1	68-70	82		1	65-68	75
	2	70-72	80		2	70-73	80
	3	70-75	80		3	70-75	85
D	0	73-75	83	P	0	60-65	72
		60-65	75		1	58-60	65
	2	65-70	79		2	60-62	72
	3	74-76	90		3	65-67	70
N	0	70-72	80	R	0	65-68	78
	1	62-64	80			60-65	77
	2	70-74	80		2	60-64	75
	3	70-72	87		3	60-65	72
F	0	70-72	82	K	0	65-70	78
	1	65-70	85		1	62-65	81
	2	60-65	78		2	60-65	74
	3	70-72	82		3	65-70	80
O	0	65-70	77				
	1	65-70	82				
	2	68-70	80				
	3	65-68	80				

cured. It will be noted that in general the hardness varied from 75 to 85, or within 10 points.

(Part IV, the last of the series, will be published in our next issue.)

Legal Notes

BY WELLINGTON GUSTIN

Reliability of Trade Journal Quotations in Trade Contracts

On appeal to the Supreme Court of Washington, the Trans-Pacific Corporation has been able to have the judgment obtained against it by the Marden, Orth & Hastings Corporation reduced from $15,680 to $13,440. The reduction is due to the difference in the market price of Manchurian pressed soya bean oil. The lower court had found that the breach of the contract for sale of said oil had occurred on April 11, 1918, while the Supreme Court determined the date to have been Feb. 19, 1918.

The action arose out of a contract between the parties for the delivery of 400 long tons of the soya bean oil. The contract of sale, under date of November, 1917, called for a price of $14.25 per 100 lb., the oil to be shipped immediately from the Orient and delivered c.i.f. (cost, insurance, and freight paid) at Seattle, Washington. The oil in due course should have arrived in Seattle in about four weeks. The contract was made through Horace J. Holley & Co., brokers, and payment was to be made upon arrival of the oil at Seattle.

After making the contract the Trans-Pacific Corporation requested and obtained from the purchaser corporation a letter of credit of $130,000 issued by the Equitable Trust Co. of New York. This was done as a matter of accommodation by the purchaser to aid the seller in procuring and shipping the oil from the Orient, so as to hasten delivery. The letter of credit referred to the shipment of oil as f.o.b. Seattle, when it ought to have been c.i.f. Seattle. This error, however, was corrected within a few days at the request of the seller. But some delay was occasioned thereby in furnishing the letter of credit as requested, which the seller claimed was an excuse for its failure to deliver the oil as contracted for, the price of oil advancing in the meantime.

There was nothing in the contract indicating that the purchaser was to furnish any letter of credit to aid the seller in procuring the oil in the Orient. Further, there were negotiations subsequently between the parties and an extension of time was mutually agreed upon for delivery of the oil. Hence this excuse for failure to deliver was unavailing.

HOLDING OF COURT AS TO DATE OF BREACH OF SALE CONTRACT

The Supreme Court fixed Feb. 19, 1918, as the date for breaching the contract by the seller, because the purchaser had notified the latter by letter that, unless some definite advice be had as to delivery of the oil by that date, it would buy the quantity contracted for in the open market and charge the difference in price to the seller. The seller made no response to this letter and the purchaser wrote other letters demanding damages for failure to deliver the soya oil. Finally the seller wrote the purchaser, April 11, declining to accede to its demands. This date was fixed upon by the trial court as the date for breaching the contract when the market price of the oil was 16c. per lb. in Seattle. But the Supreme Court held that the purchaser's letter fixed the date as of Feb. 19, when it gave notice that it would go into the open market and buy. The price of the oil at this date was 15¾c. per lb., which marks the reduction in the judgment rendered.

LEGAL VALIDITY OF TRADE JOURNALS' MARKET QUOTATIONS

Finding a proper market price for determining the damages resulting upon a breach of a sales contract is often a difficult matter. Market quotations in recognized journals and trade papers have become acceptable to the courts in finding values, and this results in a great advantage to business men and to trade and industry. Men may contract with reference to such quotations, and have a ready basis for determination of their losses and gains.

In the instant case the market value of soya bean oil at Seattle was established by quotations from a trade journal. Appealing from the trial court's ruling admitting several issues of the journal in evidence, counsel for the seller contended such market reports were too unreliable to be received as evidence. The Supreme Court held that, since other evidence showed the journal to be one of repute, and its quotations of market prices of oils, including soya bean oil, to be accepted by the trade generally throughout the United States as reliable and trustworthy, the journal was properly received in evidence.

The general rule as to the admissibility of such evidence to show market value of standard commodity of merchandise was quoted by the court as follows:

"It is a rule recognized generally that market reports or quotations as contained in newspapers, trade journals, trade circulars, price lists, etc., are competent evidence of the state of the market. Indeed, such reports, based as they are upon a general survey of the whole market, and constantly received and acted upon by dealers, are far more satisfactory and reliable than individual entries or individual sales or inquiries, and courts would justly be subject to ridicule if they should deliberately shut their eyes to the sources of information which the rest of the world relies upon, and demand evidence of a less certain and satisfactory character. Such evidence is within an exception to the general rule barring the admission of hearsay evidence inasmuch as it comes from a public authentic source which is deemed to give it reliability."

No Liability if Experienced Employee Chooses Unsafe Methods

In case of negligence brought by an employee against the Monroe Oil & Fertilizer Co. a judgment in favor of the company has been affirmed in the Georgia Court of Appeals. The evidence shows that the plaintiff employee undertook to put a belt on a rapidly revolving pulley, and was injured in so doing. It also appears that the employee had a choice of two ways of putting the belt on the pulley, one a safe way and the other a dangerous one. Both of these ways were known to the employee and he chose the dangerous way.

The employee having selected the dangerous way, he cannot recover of the employer for his injuries thus sustained, although his conduct in selecting that way may not have amounted to actual rashness, said the court.

The Galvanometer*

BY E. F. NORTHRUP

BY MEANS of instruments we learn that certain forces in nature are active and energy transformations are in progress, the very existence of which would otherwise remain forever hidden because they affect no sense of the living organism. Thus instruments are required for the detection of the feeble electric currents which circulate in the soil, or the magnetic field of the earth, or the radio-active transformations of slowly disintegrating matter, or Roentgen rays, or ultra-violet radiation, or long electromagnetic waves. These forces and many others excite no response in the living organism, which is unprovided with senses for their detection. (One may here suggest that perhaps Sir Oliver Lodge, or his associates, will yet devise an instrument which will be sensitively responsive to disembodied spirits when they make a near approach. The invention would be welcome because the five senses of most people seem disappointingly inadequate for giving informing knowledge!)

The facts are that the history of the acquisition of modern scientific knowledge in all its branches is closely paralleled by the history of the invention and the perfecting of scientific instruments; instruments which reveal existences in nature to which none of the five senses is even qualitatively responsive, and a multitude of other instruments which aid and supplement the senses by immensely extending their range.

If, in some museum of high repute, a Hall of Fame should be established wherein would be gathered, and historically grouped, typical examples, held worthy of admission, of all scientific instruments of investigation, an observer would have before his eyes the entire history of science from the days of Gilbert, or of astronomy from the days of Tycho Brahe. In this Hall of Fame in prominent setting would be seen the galvanometer. Beneath it would be placed a large card on which would be printed the fascinating story of the wizard-like achievements of modern electrical science, alone made possible because of the invention of this wonderful little instrument.

DISCOVERY OF THE GALVANOMETER

The real discoverer of the galvanometer was Oersted, when in 1820, only one hundred years ago, he noted that a compass needle placed close to a wire transversed by the electrical current set itself at *right angles* to the wire. Here was discovered a new force entirely unique, and an instrument absolutely new was invented. This force could never have been noted if man had worked with his five senses only.

All galvanometers constructed from that day to this depend for their action on this observation made by Oersted. In some instruments the wire which carries the electric current is stationary and a delicately suspended magnetic needle is allowed to turn. In another class of instruments the wire which carries the current is wound up into a coil and this coil is delicately suspended and turns in the field of force supplied by a massive magnet, itself held stationary. Thus galvanometers are divided into two general classes: moving-magnet and moving-coil galvanometers, but both groups operate alike obedient to the forces discovered by Oersted.

*From Pyrolectric Bi-Monthly Bulletin No. 11.

The moving-magnet galvanometer was brought to a high state of development and given astonishing sensitivity by the then Sir William Thomson. Due to his invention of this marvelously sensitive detector of feeble electric currents, the successful registering of signals sent over the first transatlantic cable was made possible. To it we owe, in truth, the first realization of practically instantaneous communication between the two worlds on the opposite sides of the Atlantic.

THE MOVING-COIL GALVANOMETER

The moving-coil galvanometer has no single achievement so brilliant as this in its record, because it can be made only a fifth or a tenth as sensitive as the moving-magnet form. It is, however, a far more convenient and less erratic instrument to work with, and for this reason has taken its place, in preference to the more sensitive moving-magnet galvanometer, as the most used of scientific tools in every laboratory of physical research and instruction throughout the world. When this instrument is supplemented with current-carrying shunts, currents of the greatest magnitude producible—20,000 amp. or more—can be measured, and yet this simple instrument when designed to peer, as it were, into the micro-cosmic world can detect the existence of an electric current too small for the imagination to conceive. Thus a moving-magnet galvanometer, with good working qualities and designed for very moderate sensibility, will give a millimeter deflection on a scale one meter from its mirror when 188×10^{-9} amp. flows through its coil. This figure means nothing to the mind unless translated into an idea which in some measure can be conceived. Thus the current which this galvanometer will easily measure bears the same relation to an ampere, which is about the current used to operate a large incandescent lamp, as do 240 centimeters to the diameter of the earth.

The moving-coil galvanometer has received at the hands of designers protean forms and has been made to meet the most varying requirements. No single instrument can fill all the requirements of a laboratory of instruction or the exacting demands of research. Certain features, however, have come to be recognized as useful embodiments in any instrument of this type. Among features which I judge to be generally desirable may be listed the following:

EXTREME SIMPLICITY OF CONSTRUCTION

Most laboratories make use of many galvanometers and simplicity of construction enables the instruments to be manufactured at low cost so many can be purchased. Then, too, those unfamiliar with the handling of galvanometers will much more readily acquire skill in handling an instrument of good performance but simple construction than they would one of slightly better performance obtained at the expense of refinements secured by more elaborate construction.

MOVING PARTS VISIBLE

It is a great convenience to have the entire moving system of the galvanometer plainly exposed to view. The instrument is much more readily leveled up and when using the instrument to detect when a Wheatstone bridge or other instrument is balanced, it is convenient to be able to make preliminary adjustments by observing the movements of the coil itself, re-

ferring to the spot on the scale only when the adjustments grow close.

Protected Suspensions

The upper suspension of a galvanometer is readily broken and the lower spiral suspension becomes easily tangled. The upper suspension should therefore be attached to a delicate spring at its upper end so that a slight pull on the suspension will only stretch the spring and not break the suspension. The lower, spirally wound, suspension should consist of a long spiral not easily tangled.

Adjustment to Zero

The adjustment of the moving coil to bring the no-current reading to the zero of the scale should be easily effected; a touch of the forefinger on the adjusting device should do this.

Good Working Parts

The rotating parts should be so proportioned that without loss of sensitivity the galvanometer will reach a full deflection in from two to three seconds.

Sensitivity

It is a frequent error to adjust a galvanometer to a far higher sensitivity than the nature of the work requires. A sensitivity of ½ megohm for each ohm of coil-resistance will more than meet general requirements. High sensitivity obtained at the expense of an unstable zero reading is always to be avoided.

Coil Clearance and Stability

The inexperienced find usually extraordinary difficulty in setting up and operating a galvanometer which possesses a very small coil clearance. The slight advantage of extra sensitivity obtained by making the coil clearance very small is wholly offset by the practical difficulties in setting up and operating the instrument. The accidental passage through the coil of a large current is sooner or later likely to happen and provision should be made to prevent in this case the coil from spinning several times around, thus twisting up its suspensions.

Galvanometer Mounting

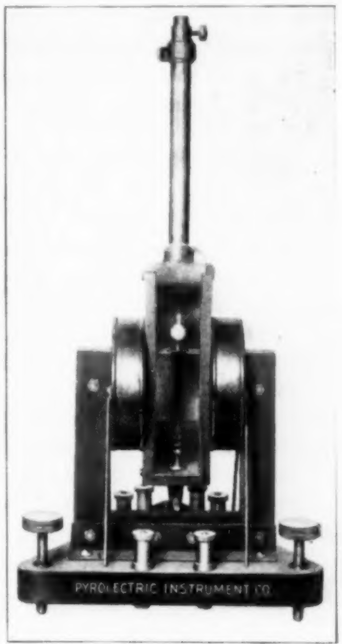
The instrument should be so designed that, with little trouble in effecting the change, the galvanometer may be mounted either on a wall or on a stand to be used on a bench or table.

Alternating Current Galvanometers

The alternating current galvanometer, such as illustrated, while primarily designed for use with alternating currents, is extremely valuable for several classes of work in which the direct current galvanometer is ordinarily employed. The following applications are pertinent:

1. For the accurate measurement of the resistivity or conductivity of salt solutions and other electrolytes.

Various devices have been employed for measuring the resistivity of electrolytes, using the Wheatstone bridge method and an alternating current as a measuring current. Among these devices the instrument most used as a detector is the telephone receiver. The a.c. galvanometer may, however, be substituted for telephone receiver to very great advantage.



A. C. GALVANOMETER

2. For the measurement of the resistivity of molten salt.

This may be done by a method not essentially different from that described by Northrup & Sherwood in the *Journal of the Franklin Institute* for October, 1916, in a paper entitled "New Methods for Measuring Resistivity of Molten Materials; Results for Certain Alloys." The above-mentioned paper describes a method in which a "resistometer" is used in conjunction with an a.c. galvanometer and Kelvin double bridge.

3. For the measurement of resistivities of molten metals. Metals in a molten state and at a high temperature invariably develop parasitic emf.'s where the potential terminals are located, and thus preclude the use of direct currents when measuring resistivities by the Kelvin double bridge method. By using alternating currents and an a.c. galvanometer their resistivities are easily measured. See numerous papers by the writer, in *Journal of the Franklin Institute.*

4. For the measurement of any resistance in which small irregular emf.'s exist.

By the use of an a.c. galvanometer and an alternating current, the resistance of a circuit or portion thereof containing a thermal emf. or even small battery emf.'s is measured as readily as a resistance free from these emf.'s is measured by using direct current and an ordinary d.c. galvanometer.

5. For high sensitivity direct current characteristics.

When the field coils of this instrument are excited with direct current, the sensitivity obtained is dependent on the strength of the field current. It is possible to produce a sensitivity of measurement (either current or voltage sensitivity) with this instrument that is unattainable with other instruments.

The writer prefers the a.c. galvanometer for all classes of resistance work and uses it invariably in his own laboratory.

The Potash Deposits of Germany

The potash deposits of Germany, which were discovered by the Prussian Government in 1843 at Stassfurt while boring for rock salt and which occur in upper layers of rock salt in the plains of northern Germany, have been estimated to occupy a volume of 10,790,000,000 cu.m. and to contain 20,000,000,000 metric tons of potash salts, corresponding to about 2,000,000,000 metric tons of potash (K_2O), a quantity sufficient to supply the world for 2,000 years at the present rate of consumption. These beds, according to the United States Geological Survey, Department of the Interior, were first exploited about 1860, and have furnished practically the entire world's supply of potash for many years.

New Process of Japanning

Baking japan as ordinarily used in manufacturing consists of two elements, the base and the solvent. The base is usually some variety of asphalt, combined with linseed or some similar oil, the whole making a hard rubbery-appearing substance. This must be liquefied for use, and the common practice is to dissolve it in naphtha or kerosene. The process of japanning various metal articles consists in dipping them in the liquid japan, and then baking them in an oven.

Owing to the volatile and inflammable type of the solvents used, this baking process is somewhat hazardous. After several bakings have been consummated, the atmosphere in the oven resembles that of the inside of a gasoline engine cylinder, only needing a spark, or even excessively high temperature, to cause an explosion of great force. Occasionally the results of these ovens blowing up have been disastrous, due to losses from fires, caused by the explosion.

Non-Combustible Japan Solvent

The manufacturers consequently became interested in the possibility of developing a type of japan which has a non-combustible solvent. The Research Laboratory of the General Electric Co. was requested to try to evolve such a product, and a course of research resulted in the development of a variety of japan which eliminated the necessity of a solvent possessed of the destructive propensities of the conventional kinds.

This water japan, as it is called, is an emulsion of the asphalt oil base with water. By this is meant that infinitesimal particles of the base are held in suspension in the water, instead of being dissolved in it. It was found that this japan had no tendency to settle out, even after months of storage, and that, owing to its being "suspended" in water, losses by evaporation were practically negligible.

Methods of Japanning

The methods of applying the japan are two in number: the electric dip and the hot dip.

The first method, or the electric dip, which is the most appropriate for small articles, consists in placing them, charged positively, in a negatively charged iron tank of japan. The result is that an even, smooth coating of japan is deposited on the articles in question, and, since the japan is deposited free from solvent, there is no resultant drip when the lot is conveyed to the baking ovens.

The second method, or the hot dip, which is applicable to large pieces of metal, was found more or less by chance. It has been the custom in the laboratory to pre-heat the metal before dipping, in order to free it from dirt and grease. This pre-heating evidently had the same effect of causing the japan to form a deposit on the metal as the giving to it of a positive electrical charge would have.

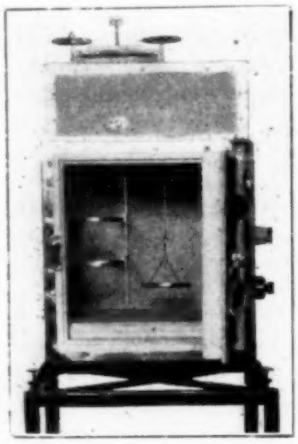
A third method is also sometimes used which is a combination of the two already mentioned; that is to say, the metal to be japanned is both heated and positively charged.

The result has been that a variety of japan has been evolved that gives exactly the same effects as the solvent variety. It is cleaner to handle, owing to the absence of drip, and eliminates the danger from explosions and disastrous fires that were such an unpleasant feature of the old form of this highly necessary compound.

Apparatus for Rapid Determination of Moisture

A labor-saving weighing device for determining the amount of moisture in a sample of paper, coal, glue, dye, soap, etc., has recently been brought out on the market by the Williams Apparatus Co. of Watertown, N. Y.

The apparatus consists of a double-walled electric oven with thermostatic control. Torsion balances accurate to 0.1 per cent, with weighing pan so constructed that the sample can be weighed either outside or inside the oven, is situated on top of the oven. The beam of the balance is designed so that the percentage of moisture can be read directly, thus eliminating all calculations.



To determine the percentage of moisture in a sample, set the thermostat to hold the temperature at the desired point. Temperature of the oven is then read from a thermometer inserted through the side. After constant temperature has been obtained, adjust the balance to equilibrium by means of tare weights, and weigh sample in the usual manner. Place the weighed sample on a weighing pan in the oven and allow it to remain until balances no longer register a loss. Again bring balances to equilibrium by means of sliding weight on beam. The sample is then at constant weight and the percentage of moisture is used directly. The time required is usually about ten minutes. Separate pans are provided so that several samples may be drying at the same time.

The advantage of such a mechanism in control work over the old method of weighing is self-evident, when one considers the considerable amount of time lost by the old method in weighing, using a dessicator, cooling, reweighing, and then repeating the process until a constant weight is finally obtained.

Power Hammer for Pulverizing Pig-Iron Samples

The time and labor required for pulverizing samples of pig iron for analytical purposes can be greatly reduced by the use of a Fairbanks power hammer, which the United Hammer Co., Boston, Mass., has designed for laboratory use. Pieces of pig iron ½ in. to ⅜ in. diameter can be pulverized in two or three minutes so that particles are fine enough to pass an 80-mesh sieve.

In one plant where this machine was installed it formerly required the labor of three men with 26-lb. sledges for twelve minutes to reduce ½-in. cubes to a sufficient degree of fineness. By the use of the power hammer the labor of two men was dispensed with and the time of the operation reduced from twelve minutes to two minutes.

The Fairbanks machine is built in two types, either belt- or motor-driven, with a 100-lb. weight of ram and 2-in. mortar and pestle. The advantages of the machine are simplicity of operation, the fact that it is under control of the operator at all times and that it is capable of striking a blow of about 600 lb. when running at 300 r.p.m.

Synopsis of Recent Chemical & Metallurgical Literature

Infusorial Earth Industry.—The results obtained during fifteen years of research and practical work by A. BIGOT, on infusorial earth, are described in the February, 1920, issue of *Revue de l'Ingénieur et Index Technique*, pp. 301-326. After giving some information on the raw material, its formation and geographic distribution, he describes and illustrates diagrammatically the influence of heat on its properties. Thus: The porosity increases with the temperature, but its aspect and volume remain the same up to about 700 deg. C. (1,290 deg. F.). Above 700 deg. C. (1,290 deg. F.) and especially beginning with 1,000 deg. C. (1,830 deg. F.) the shrinkage is very pronounced, the density rising from about 0.5 to about 2.2. The vitrification point and temperature of fusion vary between 1,300 and 1,600 deg. C. (2,370 and 2,910 deg F.) according to its chemical composition. The higher the percentage of silica the higher the melting point.

M. Bigot describes and illustrates its main properties, especially its power of absorbing gases and liquids, and its hardness. It is also sound-proof and a heat-insulator. These properties contribute to the great variety of its industrial applications, among which the most important are:

(1) As oxidizer and antiseptic used for bleaching, disinfecting and purifying.

(2) To precipitate gelatinous, colloidal or albuminous matter, in sugar refineries, breweries, distilleries, wineries, or oil refineries.

(3) To absorb liquids, when it finds convenient applications in the manufacture of dynamite, as a disinfectant, a fine abrasive, in fertilizers, in paints, in pharmaceutics and perfumery.

(4) As a sound insulator it can be used in the form of powder, granules or bricks. Taking the sound-insulating property of air as unity, that of a 0.5 density infusorial earth would be about 500.

(5) For light building construction.

(6) As heat and cold insulator, when it is used mainly as insulating material in the construction of industrial furnaces and refrigerators.

Resistance of Steels to Machining.—An explanation of the fact that some steels of a given tensile strength cannot be machined with tools which can be used for steels of higher tensile strength based upon the supposition that tensile strength at the neck is directly proportional to the cutting hardness is advanced by CH. FREMONT in a note presented at the March 1 meeting of the French Academy of Sciences (*Comptes Rendus*, vol. 170, No. 9, pp. 513-514). He cites the case of a steel of tensile strength of 78 kg. per sq.mm. (111,000 lb. per sq.in.) which could not be machined by a certain tool, whereas another steel of tensile strength of 121 kg. per sq.mm. (172,000 lb. per sq.in.) was readily cut by the same tool. If, instead of figuring the tensile strength of the steel on the basis of the original cross-section of the test piece, the ultimate strength be calculated on the basis of net section of the test piece at rupture, more concordant results may be expected. Thus the above-mentioned two steels of tensile strength of 78 and 121 kg. per sq.mm. have in reality a final tensile strength on the net section of 195 and 165 kg. per sq.cm., by which fact the author explains why the given tool could act on the second and not on the first steel.

Influence of Cadmium on Brass.—In the November-December, 1919, issue of the *Revue de Métallurgie*, LEON GUILLET gives a description of the influence of cadmium on brass. The study is timely because the greater part of zinc from western United States contains cadmium in varied amounts. He worked on brasses composed of electrolytic copper, belgian zinc (Vieille Montagne) which is free of cadmium, and metallic cadmium.

The first series of alloys he prepared contained copper 70 per cent, zinc 30 to 25 per cent and cadmium up to 5 per cent. These were submitted to mechanical tests and metallographical studies both before and after the mechanical tests. He gives tables of the different alloys he made and their behavior.

The tests show that:

(1) Up to 0.74 per cent Cd the tensile strength, elongation, resiliency and hardness are not affected.

(2) With 1.67 per cent Cd the elongation diminishes, the alloy becomes brittle and the hardness is somewhat increased.

(3) With 1.92 per cent Cd tensile strength is low, the elongation very small, the resiliency (Charpy impact) low.

(4) With 4.11 per cent Cd the tensile strength becomes insignificant.

The main conclusions to which he arrived are:

One per cent cadmium in brasses with 70 to 60 per cent copper has no appreciable effect.

A cadmium content of more than 1 per cent has a detrimental influence, especially on resiliency.

The changes in the mechanical properties of the brasses are due to the cadmium being present in a free state in the alloys.

Electric Steel Furnaces in Australia. — According to a recent article in the *Industrial Australian*, the manufacture of electric steel has been in operation for some time in Australia. The first plant erected was that of Australian Electric Steel, Ltd., at Alexandria, Sydney, comprising two furnaces of the Electro-Metals type, each having a capacity of two tons. The plant is equipped with all the usual appliances for foundry work, and castings have been turned out in considerable variety for special purposes. Ingots have also been supplied ranging in size from 4 in. square up to 24 x 12, and some of these have already been used for the forging of railway axles with successful results.

In Victoria an important step was taken last year by the Railway Commissioners toward introducing electric furnaces at the Newport shops, when three members of the staff of the Railway Department were sent to America and Canada for the purpose of making inquiries and securing all the information necessary to enable a furnace to be installed. An ample supply of cheap electric current will soon be available for use at Newport from the Department's own power house, and it is desired to take advantage of this fact to supply the demands of the railways for high-grade steel castings.

The Victorian Iron Rolling Co., of Melbourne, is also installing a plant for the production of high-grade steel. In this case the furnace will have a capacity of six

tons, and it is expected to produce about 30 tons of steel per day. The electric current is to be obtained from the Melbourne City Council's mains, and the plant will be in operation within the next few months. In the Newcastle district another company, the Commonwealth Steel Products Co., is about to commence operations. This firm is now erecting a complete plant for making electric steel, rolling tires and forging railway axles, close to the Waratah railway station. The plant is now being erected, and the furnace will use scrap steel. It will derive its current from the Newcastle City Council's supply, and will require 1,500 hp. to operate it. Special interest attaches to the tire mill, which is of a type used extensively both in America and in England, but is the first of its kind to be installed in Australia.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Manganese and Its Alloys.—Manganese or manganese alloys, low in carbon and silicon, are obtained by oxidation of a manganese alloy comparatively rich in silicon, for example, one containing more than 20 per cent of manganese and more than 10 per cent of silicon, by means of air or oxygen with or without manganese oxides or lime. The production of silicomanganese and the oxidation of the silicon may be effected in the same furnace or in successive furnaces, or ordinary silicomanganese may be mixed in the solid state with the oxidizing agents and the mixture heated to the necessary temperature, or molten silicomanganese may be bessemerized in a basic neutral or acid-lined converter with or without the addition of lime or manganese oxides, or a raw manganiferous material may be reduced with carbon in such a way as to form a manganese silicide which is thereafter oxidized. A similar procedure is used for the production of chromium and its alloys. (Br. Pats. 135,186 and 135,187—1919. AKTIEBOLAGET FERROLEGERINGAR 1, Stockholm; Jan. 21, 1920.)

Treating Fibrous Materials.—Straw, wood, flax, jute and other vegetable fibrous materials are boiled in water with a mixture of one to four parts chalk or other form of calcium carbonate and one part of an alkali compound of low causticity, such as sodium sesquicarbonate, to produce fibers suitable for spinning, for yarns, or for rope making, or to obtain a paper-making material. The residual liquor or the paste settling from it may be used as a detergent with or without the addition of sodium carbonate or soap. (Br. Pat. 135,240—1919. AMBER SIZE & CHEMICAL CO., London, and C. WEYGAN, Maidenhead, Berkshire; Jan. 21, 1920.)

Catalysts.—Catalysts, more particularly for use in the hydrogenation and dehydrogenation of organic substances, are prepared by heating (while excluding air and without the introduction of a reducing agent) an organic salt of a catalytic metal capable of producing hydrogen, for example nickel formate or oxalate, or a mixture of salts such as sodium formate and nickel sulphate. Acetates and lactates may also be used. Other catalytic metals are cobalt, iron, copper, manganese and cerium. The organic salt may be mixed with a substance which will form a support for the catalyst, and will be either inert or adapted to modify the activity of the catalyst or the cause of the reaction. Examples of such additions are infusorial earth, silica, boric acid and the carbonates, formates, and oxalates of the alkali, alkaline earth and earth metals. As a support there may also be used a metal, preferably the same as the catalytic metal in the form of wire, strip, sheet or cloth, the organic salt or mixture of such salts being either pasted on or formed either directly or indirectly on the surface portions of the metal support. (Br. Pat. 135,510—1919; A. BROCHET, Montereau, France; Jan. 28, 1920.)

Purifying Oils, Fats and Fatty Acids.—Fatty acids and their glycerides, especially fish oil and fats, are purified and deodorized by heating, admixture with a porous and powdered substance such as kieselguhr, and treatment with a non-oxidizing gas or a non-aqueous vapor such as petroleum ether or ethyl acetate. (Br. Pat. 135,295—1919. G. CALVERT, Elmhurst, Middlesex; Jan. 21, 1920.)

Vaccines. — Detoxicated vaccines are prepared by dissolving bacteria in alkali and reprecipitating with acid, the process being repeated until the supernatant liquid gives no precipitate with picric acid. As a modification the first precipitate may be washed with a solution of NaH_2PO_4 or other weak acid to remove toxins. The precipitate obtained by either method is either dissolved in alkali or mixed with a solution of NaH_2PO_4 for use. (Br. Pat. 136,036—1919. D. THOMSON, London; Feb. 4, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Ammonia Saturator.—Ammonium sulphate is prepared by absorbing the ammonia in sulphuric acid flowing over staggered baffle plates in a lead-lined cast iron tower. The flow of gas and acid is counter-current. (1,331,784; ARTHUR ROBERTS of Evanston, Ill., assignor, by mesne assignments, to American Coke & Chemical Co.; Feb. 24, 1920.)

Synthetic Thymol from Para-Cymene.—Para-cymene (1-methyl-4-isopropyl-benzene) is nitrated so that one NO_2 group is introduced in position 2. The nitrocymene is reduced with iron and hydrochloric acid to amino-cymene or cymidine, which is sulphonated. The cymidine sulphate is converted into cymidine sulphonic acid by a "baking process" similar to that employed for the preparation of sulphanilic acid from aniline sulphate. This produces 1-methyl-2-amino-4-isopropyl-3(or 5)-sulphonic acid. The animo group is eliminated by diazotizing and reducing with alkaline stannous chloride or copper powder and formic acid. The sulphonic group may now be substituted by hydroxyl by fusion with sodium hydroxide. This gives 1-methyl-3-hydroxy-4-isopropyl-benzene or thymol. After acidifying the solution, the thymol is recovered by steam distillation. (1,332,680; MAX PHILLIPS of Evansville, Wis.; filed under the act of March 3, 1883; March 2, 1920.)

Current Events
in the Chemical and Metallurgical Industries

May Meeting of the New York Section, A. C. S.

The regular May meeting of the New York Section of the American Chemical Society was held Friday evening, May 7, in Rumford Hall. Dr. Ralph H. McKee presided. Herbert S. Sidebottom read the minutes of the preceding meeting and then asked Ellwood Hendrick to report on the action of the council at St. Louis. Three papers were then read.

THE GENERAL CHEMISTRY OF GELATINE

Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, gave some valuable information recently found in his investigations on gelatine. He reported conclusive evidence that the three states of gelatine are entirely dependent on the hydrogen ion concentration.

In using different methods from those generally applied by colloid chemists, the speaker arrived at results which can be summarized as follows:

Gelatine behaves chemically like an amphoteric electrolyte which at hydrogen ion concentrations higher than 2×10^{-5}N combines with anions forming gelatine-acid salts (e.g., gelatine chloride, gelatine sulphate, gelatine ferrocyanide, etc.), and at hydrogen ion concentrations below 2×10^{-5}N combines with cations forming metal gelatinates (e.g., Na gelatinate, Ca gelatinate, etc.). At the hydrogen ion concentration of 2×10^{-5}N (or pH = 4.7)[1]—the so-called isoelectric point of gelatine—gelatine combines practically with neither anion nor cation.

These results can be demonstrated qualitatively in a most striking way. Different samples of 1 g. of finely powdered gelatine are prepared by treatment with different acid or alkali for different hydrogen ion concentrations; the powdered gelatine is then put on a filter, the excess of free acid or alkali is washed off with H_2O, and the gelatine samples are all repeatedly washed in the same way with the same concentration of a solution of salt, e.g., M/64 $AgNO_3$ on the filter (under stirring). The free $AgNO_3$ left between the particles is then washed away with H_2O, the gelatine is melted and so much water is added that the volume is 100 c.c. in each case. The hydrogen ion concentration of each sample is determined. When the test tubes containing these gelatine solutions are exposed to light, those with a hydrogen ion concentration above 2×10^{-5}N (pH = 4.7) all turn brown or black in less than twenty minutes, while the others remain permanently clear. In gelatine solutions with a pH of 4.7 or less, all the silver was washed away; in the solutions above a pH = 4.7 it was not washed away, since it was in chemical combination. In a similar way it can be demonstrated with the proper reagents that in all cases the gelatine samples of a pH > 4.7 contain only the metal of the salt with which the gelatine had been treated, and that all samples with a pH smaller than 4.7 contain only the anion of the electrolyte with which gelatine had been treated, while at pH = 4.7 the gelatine contains neither. This characteristic fact can be demonstrated no matter what the salt is which had been used.

The speaker was able to show that these combinations of gelatine with ions occur in stoichiometrical proportions. Thus Mg, Ca, Ba and SO_4 combine with gelatine in equivalent proportions, while H_3PO_4 combines in molecular proportions.

The speaker has been able to show that these stoichiometrical relations furnish the key for the understanding of the physical properties of gelatine. It was found, for example, that gelatine phosphate shows at the same hydrogen ion concentration almost quantitatively the same osmotic pressure and other properties as gelatine salts with monovalent anion; e.g., gelatine chloride. This was expected from the fact that the anion which combines with gelatine is not the trivalent anion PO_4 but the monovalent anion H_2PO_4. On the other hand, the osmotic pressure, swelling and viscosity of gelatine sulphate are considerably lower, which was to be expected from the fact that the analytical results have shown that the ion combining with gelatine in this case is the divalent anion SO_4. The full experiments were published or will appear in the *Journal of General Physiology* (published by the Rockefeller Institute).

SILICA GEL AND ITS USES

Dr. W. A. Patrick of Johns Hopkins reviewed briefly his work upon the adsorbent properties of silicic acid gel. This gel is prepared by treating sodium silicate solution with hydrochloric acid. The gel is washed thoroughly and dried at 110 deg. C. in vacuo. Even when dried in this manner, the gel contains 5 to 6 per cent H_2O (as determined by heating in a platinum crucible with a blast lamp), but this is retained so tenaciously that the vapor pressure of water in the gel is zero mm. at 300 deg. C.

With proper precautions this material can be reproduced with definite exactness and this, together with the fact that it is chemically inert, makes it an almost ideal substance for the study of the laws of adsorption. A thorough investigation was made, using sulphur dioxide at various temperatures between—80 deg. C. and +100 deg. C. It was found that the irreversibility of adsorption noticed by previous workers on silica gel was due to the presence of traces of air in the vapor. Experiments with air-free sulphur dioxide showed the process to be perfectly reversible. The empirical equation of Freundich was found to hold over almost the entire range studied. The chief disadvantage in the use of this equation, however, is the fact that the constants are not independent of temperature. Consequently, a large number of isotherms must be determined experimentally.

From a study of their results, Dr. Patrick and his

[1]The symbol pH (Sörensen's logarithmic symbol) represents the logarithm of the hydrogen ion concentration with the sign changed. In the present instance the logarithm of the hydrogen ion concentration is log 2 + log 10^{-5} = 0.30103 + (—5) = —4.7 or 4.7 with the sign changed, so that pH = 4.7.

co-workers came to the conclusion that the adsorption of gases or vapors at all temperatures below the critical could be predicted from a knowledge of the physical constants of the gas or vapor alone. In developing this theory, a relation between the weight of gas adsorbed and the equilibrium pressure was sought. It was finally found that such a relation did exist if the volume were used instead of the weight and if the equilibrium pressure were replaced by the corresponding condensation pressure, that is $p \div p_o$ where p is the partial pressure of the gas over the adsorbent and p_o is the vapor pressure of the liquid at the temperature of measurement.

But the vapor pressure of a liquid in a capillary tube is lower than the normal vapor pressure because the liquid in capillary is under tension or negative pressure. This effect can be calculated thermodynamically. The corresponding effect on the density of the liquid in the pores can be calculated, provided the compressibility coefficient is known. Unfortunately, this has not been determined for liquid sulphur dioxide, but Richards' relation between surface tension and compressibility ($\beta\sigma^{\frac{4}{3}} = k$) suggested the use of σ in modifying the empirical equation.

The following equation (in which the constants are independent of the temperature) was found to hold for the experimental data.

$$V = K\left(\frac{p\sigma}{p_o}\right)^{\frac{1}{n}}$$

For the system silica gel-sulphur dioxide, $K = 0.1038$ and $\frac{1}{n} = 0.447$.

From the industrial point of view, silica gel offers certain advantages as an adsorbent material. While its ability to adsorb gases is about the same as that of charcoal, it is chemically inert and stable up to 700 deg. C. Furthermore, it can be easily and cheaply prepared on a commercial scale. It has been applied industrially in the drying of air and other gases, in the recovery of gasoline from natural gas and also in the recovery of solvents.

Electro-Endosmosis

Dr. T. R. Briggs of Cornell closed the program with an account of electro-endosmosis—the phenomena observed in the transposition of liquids through porous diaphragms when under electric potential. It is a general law that if two substances are brought into contact with each other, the one possessing the higher dielectric constant will become positively charged. Water has a very high dielectric constant and therefore, when under sufficient electric potential and in contact with a stationary diaphragm having a smaller constant, migrates from anode to cathode, conducting electric current in a similar manner to positively charged ions, colloidal particles, etc. If the diaphragm particles were not rigid and were free to move, they would migrate toward the anode, conducting electric current of opposite sign to that carried by the water particles. This latter phenomenon is known as cataphoresis.

Electro-endosmosis has been applied industrially as a means of pumping water from such materials as peat, but the process has not been rewarded with financial success, not, however, because it was an uneconomical or impractical method of drying. Cataphoresis has given a very satisfactory method for preparing pure clay. The clay substance is electrically conducted to and deposited in a revolving drum pole in a very pure state. A series of photographs was shown giving views of a plant and drawings of the installation. In Germany an attempt has been made to generate electric current by pumping water through diaphragms, but the frictional losses were too great to make it a competitor of the dynamo.

New Jersey Chemical Society

The regular meeting of the New Jersey Chemical Society was held in Newark Monday evening, May 10. After an informal dinner President Carleton Ellis opened the meeting. The secretary read the acceptance of many new members and announced that the society now has a membership of 390. Announcement of an excursion to the Seaboard By-Product Coke Co. on Saturday, May 22, was made.

H. E. Otting, assistant superintendent, Nestlé's Food Co., New York City, then gave a résumé of the work done by the chemists in the milk industry.

The Chemist in the Milk Industry

Too much credit cannot be given the chemist to his service both to the manufacturer and consumer of milk. By means of the Reese Gottlieb test he has brought about a standardization of milk and milk products which enables the manufacturer to meet all the existing Government requirements and insures the consumer a standard product.

He has furnished the manufacturer with accurate reports of milk products going into a case of finished goods and so developed plant control work as to keep a close check on all operations, thus reducing costs to a minimum. In addition he protects the manufacturer and consumer by careful inspection of fresh milk received at plant, and tests both raw materials and finished products for conformity to standards.

No minute detail is allowed to escape and special attention is given to the sanitary condition of the plant and its operation so that now the milk industry may be said to be run on a scientific basis.

Various milk products, such as evaporated milk, condensed milk, homogenized milk, malted milk, milk powder and infants' food were exhibited and their process of manufacture described.

Zinc Manufacturing Industry of New Jersey

John S. McKaig, of the New Jersey Zinc Co., gave a brief description of the development of the wonderful zinc deposits of Franklin Furnace, N. J. The concentration of the ores, smelting and refining of the metal, packing and shipping methods were well illustrated with moving pictures of their plant.

Some of the uses of zinc and its compounds, particularly zinc oxide as a pigment in paint and a filler in rubber, were then discussed.

Detroit Engineering Society

The Detroit Engineering Society held its annual meeting in the Palm Room of the Hotel Cadillac, Friday, April 23, with the following speakers: Mortimer E. Cooley, dean of engineering, University of Michigan; William H. Walker, director of the division of industrial co-operation and research, Massachusetts Institute of Technology; Harry M. Nimmo, publisher of the Detroit *Saturday Night;* Frank F. Kedzie, president Michigan Agricultural College, and Gardner S. Williams, of Ann Arbor, Mich.

Fate of Dyestuffs Bill

So successful has been the filibuster in the Senate against the dyestuffs bill that it is practically certain that the measure cannot become a law in its present form. What is more, there seems to be no middle ground on which the contending forces in the Senate can meet. The filibuster was non-partisan. While Senator Thomas of Colorado has taken the most prominent part the movement probably has more sympathy on the Republican side than it has on the Democratic side. The fate of the legislation is very uncertain.

While much of Senator Thomas's four-day speech against the bill was very obviously for time-consuming purposes, a considerable portion of his remarks was especially pertinent. A good idea of his argument, and of the nature of the opposition, however, can be obtained from the following short extracts from his remarks:

"Mr. Irenee du Pont was before the committee, an enthusiastic advocate of this bill. He had a right to come, and it was perfectly proper that he should urge consideration of any measure designed, as this is designed, to encourage his business. The companies which he represents in part are among the most prosperous in the United States. During the war they numbered their profits in hundreds of millions. Taken collectively, I have no doubt that with the exception of the Standard Oil Co. and the United States Steel Corporation, the du Pont aggregation is the most formidable of all American enterprises; and I shall not undertake even to guess at the extent of its accumulated millions. It is in powder, and in all the collateral branches of the industry, and it is also in the dyestuffs business.

"A man representing the colossal combination with untold capital not only demands an absolute embargo, but as high a tariff as possible, so that if the embargo should happen to leak they will still have another wall, amounting virtually to prohibition; and, in addition, he asks for the suspension of the Sherman anti-trust law, not as affecting the entire country but only as affecting the dye industry.

"I do not hesitate to say that if it is necessary in order to sustain this industry that we suspend a law universally applicable and designed to protect the people against combinations, plus an embargo, plus a prohibitory tariff, then we ought not to sustain the industry at all. It is the most monstrous proposition in legislation that has confronted me during my term of service. It is the most impudent proposal that I have encountered while serving upon the Finance Committee. Its end must needs be absolute monopoly; and I here predict, although I am not a prophet nor the son of a prophet, and may not live to see it, that if this bill becomes a law within the next five years the dye industry of the United States will be entirely in the hands of the du Ponts and the National Aniline Co.

"Embargoes are un-American, to begin with, and even when they are universal they are unjust. During the administration of Mr. Jefferson an embargo was laid upon all foreign commerce. The majority of intelligent sentiment at that time, in my judgment, very properly denounced the policy as a grave and intolerable injustice, but it was at least impartial. Like the dews of heaven, it fell upon the just and unjust. This embargo involves one, and one only, of the industries of the country, and leaves the others to go their way until in good time and due to considerations material, political, and otherwise, the terms of the legislation shall be widened and its wings extended that it may shelter other industries seemingly needing that method of protection.

"I think I have said all that I care to say upon this bill. As I stated some time ago, during the progress of the bill through the Senate I expect to offer two or three amendments, and it is only fair to the Senator having charge of the bill that I should outline them. One is the amendment which I offered yesterday to the anti-dumping bill, and which proposes an income tax upon political contributions in excess of $1,000. Another will be the repeal of the excess-profits tax and the substitution in its place of a consumers' tax. The others will be comparatively unimportant. I shall, of course, when the occasion is appropriate, offer these amendments, and have something to say to the Senate regarding them."

Consideration of Conference Report on Water-power Bill

Consideration of the conference report on the water-power bill was not taken up on May 11, as had been expected. Opposition to the conference bill developed such strength that it was evident that considerable discussion would be indulged in. For that reason the Knox peace resolution was given right of way.

The opposition comes largely from New England Senators, who contend that the bill gives the Federal Government unwarranted jurisdiction over matters coming properly within the province of the state. It is possible that certain changes in verbiage may satisfy the opposition, but as the parliamentary situation makes a filibuster easy of accomplishment it is expected that important concessions will be forced before the Senate is allowed to vote on the conference report.

House Accepts Conference Report

The conference report was accepted in the House by a vote of 259 to 30. On the motion to resubmit the bill to the conference committee, with instructions to insist upon disagreement with the Senate amendments regarding the definition of "navigable waters" and regarding charges, the vote was 86 for recommitment and 209 against. The motion to resubmit also provided for agreeing with the Senate amendment regarding the distribution of power to municipalities, which had been stricken out in conference.

While the adoption of the conference report was hailed on one hand as the best example of constructive legislation of recent years, a very determined minority sees in the bill the surrender of one of the last great public assets and a dangerous infringement upon the rights of the states. The definition of "navigable waters," as agreed upon by the conferees, was declared to violate "settled principles of law" as well as the rights of the states and of individuals. That these arguments did not carry very great influence may be judged from the vote. The vote was not partisan.

Representative MacGregor of New York, one of those voting against the conference report, objected particularly to the amendment requiring a license to distribute power to communities in the vicinity of the plant.

Representative Sinnott, one of the leaders of the House, in the course of his remarks on the bill, said: "All through this bill the right of the state is recognized. The state may fix charges and may also control securities."

Budget Bill

The conferees on the budget bill have practically reached an agreement and promise is held out of legislation before adjournment previous to the national conventions. Budget legislation, which has the approval of both parties, is expected to result in the saving of large sums annually in the conduct of the various Federal agencies. The conference bill will place all responsibility for estimates of expenditures with the President, but will put the Bureau of the Budget in the Treasury Department.

Exports and Re-exports of Chemicals

Exports of chemicals during March, 1920, were valued at $18,885,433, according to figures compiled by the Bureau of Foreign and Domestic Commerce. This is an increase of $5,675,498 in the value of chemical exports for February. Some of the items making up the total, as well as revised figures for March, 1919, are:

Exports of Chemicals:	March, 1919	March, 1920
Acids:	Lb.	Lb.
Carbolic	204,960	214.002
Nitric	58,386	106,883
Picric	633	173
Sulphuric	972,687	2.469,734
Benzol	221.546	221.211
Calcium carbide	2 177 323	3,384,816
Copper sulphate	2.009,234	705.542
Lime:		
Acetate of	174,855	2,807,977
Chloride of (bleaching powder)	1,813,346	2.564,039
Chlorate of potash	69 307	187 152
	Value	Value
Total sodas	$1,492 707	$ 2,525,098
Total chemicals	9 681,692	18,885,433
Total dyes and dyestuffs	880,247	3,635 518
Medicinal and pharmaceutical preparations	1 218.409	1.944,111

Some of the import figures, as compiled by the Bureau of Foreign and Domestic Commerce, are as follows:

Acids (except coal-tar acids):		Lb.	Lb.
Oxalic	duty	none	377,523
All other	free	1,750,815	2,011,696
	duty	118,430	515,936
Chemical and medicinal compounds:			
Alkalis, alkaloids and preparations, mixtures of	duty	280.495	670,889
Medicinal preparations	duty	42,055	70,160
		Value	Value
Total coal-tar products		$ 388,399	$ 532,311
Total gums		1,849,377	5,704,581
Total chemicals, drugs, dyes, etc.:			
Free		4.174,504	13,352.532
Duty		3.315,930	7.277,911

Re-exported chemicals, as compiled by the Bureau of Foreign and Domestic Commerce, are:

	March, 1919	March, 1920
Acids:	Lb.	Lb.
Carbolic	1,904	None
Oxalic	None	23,756
All other	7,883	236,111
Extracts and decoctions for tanning:		
Quebracho	36 583	1 170,130
All other	2,341	511,900
Gums:		
Camphor, crude, natural	None	435
Camphor, refined and synthetic	2,350	27,842
Copal, dammar and hauri	315,311	228,989
Gambier, or terra japonica	13,042	4,199
Indigo, natural or synthetic	None	66,109
Iodine, crude or resublimed	1,549	None
Licorice root	2,056	4,902
Opium, containing 9 per cent and over of morphia	1,550	38,744
Carbonate of potash	139,784	1,200
Nitrate of soda	3,083	477
	Value	Value
Total chemicals	$ 566,045	$ 1,200,828

Alcohol as Motor Fuel

Scarcity and high price of petrol have caused the British Government to seek a substitute motor fuel. Among the many possibilities, alcohol from vegetable matter seems most promising. Extensive new laboratories and a special staff of assistants under the direction of Prof. H. B. Dixon are being provided to study this important problem.

Sulphur and Phosphorus Investigation

A second statement of progress has been issued by the Joint Committee on Investigation of Phosphorus and Sulphur in Steel, whose activities have already been mentioned in these columns.*

The committee on statistics has completed a bibliography of the literature. It has also made a survey of used material in the shop of two large Eastern railroads and has secured certain high-phosphorus and high-sulphur material that has been in service, including some connecting rods, a car axle, a crankpin, some parts from a high-sulphur locomotive firebox, and some high-sulphur channels. These will be analyzed and tested by the committee on tests.

A considerable quantity of rivet steel was rolled under observation at the Duquesne works of the Carnegie Steel Co. In all, thirteen ingots (18 x 20 x 72 in. —6,400 lb.) of varying sulphur content, each from a separate heat, were rolled into billets (4 x 4 in. x 4 ft. —220 lb.). In order to eliminate any variable that might be introduced by piping or segregation, it was decided to discard 40 per cent of the steel from the top of each ingot. The next six billets after the top discard, numbered 1 to 6 in sequence, were taken for the purposes of this investigation and each billet was properly stamped with the heat and billet number. Billets 1, 2, 3 and 4 from each ingot were rolled into $\frac{63}{64}$-in. rounds, each billet yielding eight bars 9 ft. 8 in. in length; billets 5 and 6 from each of the ingots were held in reserve. In the attempt to produce a heat high in sulphur, there was obtained the unusually high analysis of 0.17 per cent.

Approximately one-half of the material was shipped to Watertown Arsenal, the U. S. Navy Experiment Station at Annapolis, and the Bureau of Standards, for the various mechanical tests. The remainder was made into rivets at the Pennsylvania Railroad Co. shops at Altoona, and the Champion Rivet Co., Cleveland, Ohio The rivets were made into two types of head, namely cone and button, and of $2\frac{3}{4}$-in., $3\frac{1}{2}$-in. and 6-in. lengths. Temperature readings of the various bars were taken with an optical pyrometer.

After careful review of all desirable tests and in the light of comments and suggestions, the committee on tests has prepared a schedule covering tension, fatigue, impact, hardness, bend, torsion and shear tests and certain tests for forgeability. Certain "fabrication" tests are also contemplated, which are particularly applicable to the rivet material furnished, such as cold and quench bends, hot flattening, upsetting and tests on the shearing strength of riveted joints.

Proposed Consolidation of Geological Survey and Bureau of Mines

A consolidation of the Geological Survey and the Bureau of Mines is proposed in a bill which has been introduced by Senator Henderson of Nevada, the ranking member of the Committee on Mines and Mining. The consolidated bureaus are to be known as the Division of Mines and Geology and are to be administered directly by an Assistant Secretary of the Interior who "shall be technically qualified by experience and education" for the position.

The bill specifies that the Assistant Secretary in charge of the division is to receive a salary of $10,000.

*CHEM. & MET. ENG., vol. 21, p. 556 (Oct. 29-Nov. 5, 1919); vol. 22, p. 297 (Feb. 18, 1920).

Chem. & Met. to Make Its Own Paper

The McGraw-Hill Co., Inc., together with the United Publishers Corporation, in an effort to solve the shortage in paper, has bought the Newton Falls Paper Mill at Newton Falls, N. Y. This mill, which now manufactures wrapping stock, will turn out magazine stock in the future. Each company holds a half interest in the property, which is valued at approximately $2,500,000.

Philosophical Society of Washington

The May 8 meeting of the Philosophical Society of Washington included a paper by F. B. Silsbee on "Physics of the High-Tension Magneto" and by C. Nusbaum on "The Magnetic Reluctivity Relationship as a Criterion of the Structure of a Eutectoid Carbon Steel." The latter paper is the first of a series of reports which are being prepared as a result of extensive investigations now in progress at the Bureau of Standards studying the correlation of the magnetic properties and physical properties with the composition and prior heat treatment of carbon and special steels.

Personal

Dr. RAYMOND F. BACON, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, who during 1918 was a Colonel in the Chemical Warfare Service, serving as chief of the technical division of the Chemical Warfare Service, A. E. F., has been awarded a citation by General Pershing for exceptionally meritorious and conspicuous services in France.

L. D. BOWMAN, of the Vanadium Alloys Steel Co., delivered a short paper entitled "Some Notes on Annealing" before the regular meeting of the Pittsburgh Chapter of the American Steel Treaters' Society and the Steel Treaters' Research Society on Monday, May 17.

Dr. FREDERIC DANNERTH, who has been retained by the C. Kenyon Co., Brooklyn, N. Y., as consulting chemical engineer, has recently accepted an invitation to become head of the company's new laboratories. He is now planning and organizing the new department and upon completion will assume charge of an extensive program of research and development.

N. E. DORSEY, physicist in charge of the radium and X-ray section of the Bureau of Standards, has submitted his resignation, to take effect at an early date—not later than July 1. Dr. Dorsey has not perfected all of his plans definitely as yet, but he expects to open consulting offices during the latter part of the summer or early fall, specializing in the application of physics to medical practice, particularly X-ray and radium application.

KARL EILERS, recently of the directorate of the American Smelting & Refining Co., has opened private offices at 233 Broadway, New York City.

A. C. FIELDNER, the supervising chemist of the Pittsburgh station of the Bureau of Mines, is conferring with New York and New Jersey state officials in connection with plans for the proposed vehicular tunnel under the Hudson River. He also conferred last week with officials of the Bureau in Washington.

E. D. GORDON, of the weights and measures division of the Bureau of Standards, has resigned to take a position as sales-engineer with the General Automatic Scale Co. of St. Louis. Mr. Gordon will be engaged in both development and special problem work for this company, which contemplates a still further extension of its lines of scales.

N. E. HEHNER, a chemist who has been in the service of the Bureau of Mines, has resigned to enter private employment.

HENRY HOWARD, formerly vice-president of the Merrimac Chemical Co., Boston, Mass., is now associated with the Grasselli Chemical Co. at Cleveland, Ohio.

Dr. C. E. KENNETH MEES, director of the research laboratories of Eastman Kodak Co., landed in England, April 27. While there he will deliver the following lectures before various scientific bodies: "Some Photographic Phenomena in Relation to Astronomy," "Some Results of Recent Investigations on the Theory of Development," "Photography From the Air," "Reaction of the Eye to Light," "A Photographic Research Laboratory," "The Production and Supply of Synthetic Organic Chemicals in the United States," "Rochester and the Kodak Works," "Scientific Research and Industrial Production" and "The Theory of Tone Reproduction With a Graphic Method for the Solution of Problems."

A. G. PETERKIN, formerly assistant general manufacturing manager of the chemical department of The Barrett Co., is now manufacturing manager of the Frankfort plant of the same company.

R. E. H. POMEROY has resigned as smelter superintendent of the Nevada Consolidated Copper Co., and will associate himself with the Bonnot Co., of Canton, Ohio, as chief engineer of its pulverized coal department.

Dr. GEORGE D. VAN EPPS, formerly non-ferrous and oil chemist for the Continental Motors Corp., Muskegon, Mich., is now analytical chemist for the Citro Chemical Co., Maywood, N. J.

C. L. WISWALL, formerly of the Hercules Powder Co., recently accepted a position as production engineer with the Vulcan Detinning Co., Sewaren, N. J.

A. L. WRIGHT, formerly consulting mechanical engineer with the nitrate division of the Ordnance Department, is doing consulting engineering work in Chicago.

E. L. YOUNG has been appointed assistant general manager of the Sunnyside Mining & Milling Co.

Obituary

ARTHUR BENEDICT BELLOWS, first vice-president of the Pittsburgh Testing Laboratory, Pittsburgh, Pa., died Saturday, April 17, 1920.

ARTHUR H. HIORNS, the founder of the Birmingham (England) Metallurgical Society and for forty years head of the metallurgical department of the Birmingham Technical School, died Saturday, April 17, at Water Orton, England.

Prof. A. K. HUNTINGTON, professor of metallurgy at King's College University since 1879, died suddenly on April 17. His appointment terminated in October last year and his colleagues state that his severance from active work had had marked effect upon him. During the war he was engaged in highly specialized work with high explosives for the Admiralty.

JOHN WESLEY HYATT, inventor of the Hyatt roller bearing, died recently of heart disease in his eighty-third year at his residence, Windermere Terrace, Short Hills, N. J. He was born at Starkey, N. Y., and received merely a common school education followed by one year at Eddytown Seminary. Moving to Illinois as a youth, he gave all his time to inventing. Next to the roller-bearing device the most widely known of his inventions is the material called celluloid. His brother, the late I. Smith Hyatt, shared in the discovery of the process of its manufacture. The following list of other patents shows the extraordinary range of his inventive talent: Knife sharpener, new method of making dominoes and checkers, the Hyatt billiard ball (including the machinery for making it), water-purifying

systems, lockstitch sewing machine, machine for squeezing juice from sugar cane, new method of solidifying hard woods for use in bowling balls, golf stick heads and mallets.

Dr. RUDOLPH MESSEL, of London, past-president and for many years foreign secretary of the Society of Chemical Industry, died April 20. His researches with Winkler and others into the manufacture of oleum are classical and were developed commercially under his guidance. Dr. Messel was in his seventy-third year.

Current Market Reports

The Non-Ferrous Metal Market

New York, May 17, 1920.—Conditions are little changed since last week.

	Cents per Lb.
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent	32@33
Antimony, wholesale lots	10.00
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	55.75
Lead, New York, spot	8.70
Lead, E. St. Louis, spot	8.40
Zinc, spot, New York	8.62½
Zinc, spot, E. St. Louis	7.60

OTHER METALS

Silver	oz.	$99.75
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.70@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.60@1.85
Platinum	oz.	110@115
Iridium	oz.	300.00
Palladium	oz.	105@115
Mercury	75 lb.	95.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper bottoms	38.50
Copper rods	27.50
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless high brass tubing	30.50

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	21.75@22.75
Aluminum, sheet scrap	21.25@22.50
Copper, heavy machinery comp	13.50@14.00
Copper, heavy and wire	13.50@13.75
Copper, light and bottoms	12.25@12.75
Copper, heavy cut and crucible	14.75@15.00
Brass, heavy	7.50@ 8.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	8.25@ 8.50
No. 1 comp. turnings	10.25@10.75
Lead, tea	5.25@ 5.40
Lead, heavy	7.00@ 7.25
Zinc, scrap	4.25@ 4.50

The Iron and Steel Market

Pittsburgh, Pa., May 14, 1920.

The rail strike has not extended, in general, rather having waned a trifle, but iron and steel operations, as affected by the rail strike, have not improved during the past week, having if anything grown somewhat poorer. The change arises from the increased scarcity of empties for loading, whether of coal, coke or intermediate or finished products. A great deal of material has been loaded without the cars getting through to destination, and even when deliveries are made the empties have more difficulty in getting back for fresh loadings than the original shipments had in getting through. A trainload of coke, for instance, is made up in the Connellsville region and is "personally conducted" through to a blast furnace, but when the cars are unloaded there are no facilities for taking back the trainload of empties.

STEEL PRODUCTION

The monthly report of the American Iron and Steel Institute, relating to steel ingot production, furnishes a convenient check. The thirty companies contributing to the monthly report produced 2,638,305 gross tons of steel ingots in April, against 3,299,049 tons (revised) in March. These companies made 84.03 per cent of the total steel ingot output in 1918. Allowing for producers not reporting, and counting the number of working days in the month and year, the rates per annum of steel ingot production for the whole industry appear to have been approximately as follows:

	Gross Tons		Gross Tons
January	40,700,000	March	45,200,000
February	44,200,000	April	37,550,000

Thus the rate in April was one-sixth less than the March rate, which was the highest since October, 1918. The month was not equally affected throughout by the rail strike, which began April 1 in Chicago, but hardly affected operations in Cleveland, the valleys and the Pittsburgh district until Monday, April 12, while toward the close of the month operations in the Chicago district had increased. Probably as high an estimate as could be justified for the present rate of production would be the average rate of April.

So much steel has accumulated at mills and in transit that the concern now is not so much about production as about distribution. March production was less than capacity by perhaps 10 or 15 per cent, production is 15 or 20 per cent below the March production, shipments are less than production and receipts by consumers are less than shipments.

A situation is presented that is difficult to analyze. Very little complaint is heard from consumers. The consumers are not exerting any great pressure upon mills to give them preference, and there is even less bidding in the open market for prompt deliveries, at the various premium prices that would be asked, than there was a few weeks ago. Possibly consumers feel it would be futile to attempt to improve their supplies by this means. Possibly many are operating by drawing upon stocks. Possibly it is a common feeling that there is no occasion for haste in making up finished products at the factories.

However the situation is viewed, it is difficult if not impossible to draw any auguries that a stronger steel market is in prospect for the near future. If the operations of consumers are greatly curtailed, then consumption is postponed, and the extra supplies of steel now accumulating, at mill and in transit, will make a larger supply for consumers than has been seen since the steel strike began. If, on the other hand, consumers are operating by drawing upon stocks, then those stocks must have been accumulated at some time, and the only conceivable time for such a process was last February and March, for certainly there were no stocks at the beginning of the year.

As to prospects of consumption, existing capacity is 40 to 50 per cent greater than capacity at the end of 1913, yet in neither of the calendar years 1913 or 1912, though those were the years of largest production before the war, was the actual production within 90 per cent of that capacity, 1912 having had a weak beginning and 1913 a weak ending. For engagement of the present capacity, therefore, a collection of favorable circumstances would appear to be absolutely requisite. The railroads, normally counted upon as large consumers of steel, are buying scarcely anything, and there is merely conjecture as to whether they will become free buyers if or when they receive a favorable settlement of the rate case now inaugurated before the Interstate Commerce Commission. As to large construction jobs, involving the use of steel, hitherto considered essential to there being a full demand for steel, there is not much of that and the immediate prospects are not promising.

BOOKINGS

The United States Steel Corporation reports unfilled obligations at the end of April at 10,359,747 tons. The corporation's rated capacity being about 52,500 tons per working day, the unfilled tonnage would be equal to 7.7 months of operation at capacity, although of course the orders are not uniformly distributed in the different products. The April increase in unfilled obligations was 467,672 tons, against increases of 389,994 tons in March, 216,640 tons in February and 1,020,075 tons in January. April

bookings nevertheless fell short of those in March, since the shipments were less than 96 per cent of capacity in March and 60 per cent of capacity in April. The increase in unfilled obligations in March represented 28 per cent of capacity, the April increase representing 34 per cent of capacity. Adding these increases to the estimated shipments gives 124 per cent as the March bookings and 94 per cent as the April bookings.

When there was such a decrease in the bookings of the low seller, one may infer that there was a larger proportionate decrease in the bookings of the higher sellers, first the group of large independents that have been selling for delivery from two to four months ahead, at, say, $10 to $20 a ton above Steel Corporation or Industrial Board prices, and next the smaller independents that have been selling for delivery in, say, two to six weeks at still greater premiums. Market observation during April agreed with this inference. The independents have not been selling at capacity by any means, and when they have maintained their prices, as the majority have done, it has been at the expense of diminishing order books. Mills that could not permit this, having little tonnage ahead, have had to reduce prices, and thus there have been declines in prices for the earliest deliveries, though the delivery premiums are still large.

Chemical and Allied Industrial Markets

New York, May 14, 1920.

With transportation reported 10 per cent normal, these markets are in such a position that producers have been forced to cut their plant forces in half because of the lack of raw material and fuel, and it is only a question of weeks before they will have to close completely. Jobbers and brokers are in a bad way, as the only supplies within easy access of New York are the unimportant items for which there is small demand. One large drug house in Boston is operating a fleet of 5-ton trucks between that city and New Jersey, but the cost of transportation of this kind is figured on 1c. per lb. gross weight, which would make the cost prohibitive for general use.

General Chemicals

Glauber's salt went up 10c. per cwt. during the week, with still further tightening of supplies. This item was listed at $1.20@$1.35 a year ago, and current quotations range from $1.75@$2.05 per cwt. One factor in this item is reported thirty cars behind his contract and is refusing to consider any new business. Producers have firmly set the price on *carbon bisulphide* at 8@11c. per lb., with fairly good supply on hand at these figures. *Caustic soda* is still nominally quoted around $6.50 per cwt. for spot material; offers have been received from Japan below the present market for resale American material, but so far none of this material has arrived. All items on the *acid* list are decidedly firm; demand for *acetic* is still heavy, with 28 per cent listed at $3.50@$3.75 for car load and $3.80@$4.00 for less than carload, while glacial 99½ per cent holds firm at $16.50@$17.50 per cwt. *Hydrofluoric acid,* 52 per cent, continues in good demand at the recently fixed price of 12@14c. per lb., while *hydrochloric,* 20 deg., is still nominal at $3@$4 per cwt.

Coal-Tar Products

No improvement has been noted in this market during the week. Conditions as previously reported still prevail and there is very little material being offered on any of the items throughout the list. *Naphtha* has shown some indications of weakening, and it is said some material changed hands at 14c., but 15c. of last week still holds as an average price. *Alpha naphthylanine* came up during the period and is listed at 65@70c. per lb., against 50@60c. of the previous report. There is very little of this material being offered even at the new price. *Benzol,* water white, can be had for 27@36c. and 90 per cent is 25@31c. per gal. f.o.b. plant. *Toluol,* in practically the same position, suffering from shipping conditions, is listed at 28@32c. per gal. subject to delivery.

Naval Stores—Flotation Oils

Quotations on these items remain wholly nominal and the listed price will take effect upon arrival of material from the primary market. *Turpentine* came down slightly and is now quoted at $2.45 per gal., against $2.50 of last week. All grades of *rosin* have changed hands at prices ranging from $19 to $24 per 280 lb., but these prices will be broken shortly, as the Savannah market has already shown some signs of weakness. Practically the same thing holds true of the flotation oils, as material en route from the South is being held up, which upon arrival will relieve the present pressure.

Vegetable Oils

Dullness has been the predominating note of this market during the week. Buyers are not displaying any interest in future offerings due to the uncertainty of the transportation tangle. Business has been done in a small way on some of the items, but that is the best that can be said. *Linseed* is handicapped by the delivery problem. There has been increased activity on this item recently, but producers in the West are unable to ship any goods. Current quotations are firmly maintained at $1.72 per gal., raw, car lots; $1.67, raw, tank cars, and $1.75, boiled, car lots, with contracts subject to delivery.

Miscellaneous Materials

Like all other markets, there is very little material moving into this market. *Feldspar* remains unchanged with $13.50@$18, ground grade, f.o.b. New York State, still holding firm, while *barytes,* listed at $36@$40 for white floated, is in a wholly nominal position. *Fullers earth* is still scarce and $25@$30 for domestic and $35@$40 per ton for foreign is firmly maintained.

St. Louis, May 11, 1920.

The local production of heavy chemicals is curtailed due to manufacturers' inability to get raw material and supplies regularly on account of the railroad switchmen's strike. Railroad service is from 15 to 30 per cent normal. This situation has materially affected the chemical market and supply of practically all chemicals is very limited. No relief is expected until railroad service is back to normal. Prices are erratic and are based on supply available. The St. Louis district has had to depend almost entirely on local manufacturers to supply their needs.

Sulphuric Acid—Supply is practically limited to local production and stocks are low. The 60 deg. grade is quoted at $15 per ton and 66 deg. grade at $22 per ton. Oleum is quoted at $27 per ton.

Muriatic Acid—The demand exceeds the supply and quoted at $20@$22 per ton for the 18 deg. grade. The muriatic acid plant of the Monsanto Chemical Works, East St. Louis, was partially damaged by an explosion in a nearby oil refinery and production is temporarily curtailed.

Sodium Bisulphate—Supply limited and quoted at $4 per cwt.

Nitric Acid—Local supply practically exhausted and demands exceed local production.

Zinc Chloride—Available supply exhausted. Last quotations approximately $4.50 per cwt.

Zinc Oxide—Demand for this chemical is heavy and local output for second quarter practically all contracted for. Last quotation 9¾@10c.

Phenol—There is a good demand for phenol, which is quoted at 12c. per lb. Supply is plentiful due to surplus which the Government is disposing of.

Caustic Soda—Supply is very limited, although several shipments have been received lately. It is quoted at 7c. per lb. 76 per cent test in carload lots.

Soda Ash and Silicate of Soda—Local supplies practically exhausted.

Hydrofluoric Acid—Local supplies practically exhausted.

Chicago, May 13, 1920.

Existing conditions in regard to transportation are such as to cause reports on Chicago market conditions in the chemical trade to be of almost purely local interest. While it is perhaps true that in general the railroad situation is

improving and that shipments are moving a little more freely now than two or three weeks ago, the chemical market has experienced but little relief. A great portion of the traffic in chemicals takes fifth or sixth class in freight classification and therefore receives but scant consideration in the present emergency. The effect has been practically to isolate Chicago from the rest of the country and to put each purchase purely on a basis of how much the buyer can afford to pay rather than go without the needed goods.

Stocks in most lines are probably lower than they have ever been before. It is now possible to procure shipments in limited extent from manufacturing points to Chicago and from Chicago to most destinations. Direct shipments from points outside of Chicago, through Chicago to a third city as the point of destination, are still impossible. This works as a severe handicap on direct shipments.

The tendency of buyers to stay out of the market unless their needs are absolutely essential to the conduct of their business, which was noted two weeks ago, continues. The consuming trade recognizes the fact that present conditions are such as to make it purely a sellers' market, and they are therefore reluctant to enter the buying field. This tendency has prevented any general skyrocketing of prices, though in practically all cases spot market is considerably above the figure asked for goods on contract for future delivery. Collections are, of course, tight. The greatly lengthened period of time consumed by goods in transit has tended to make payments slow all along the line and is amounting to a severe burden on both the dealer and the manufacturer.

The shortage of spot stock is most severely felt in the coal-tar products and in the alkalis.

Heavy Chemicals

Previously noted conditions tending to keep the prices of various grades of *alcohol* at a very high level have become accentuated by the difficulty of manufacturers securing raw materials, particularly molasses. The current market quotation on *ethyl* grade of \$5@\$5.50 per gal. is purely nominal. Actual transactions of the past two weeks have been very small in quantity and have ranged in price all the way from \$6 to \$10 per gal. *Methyl* grade is just about as scarce as ethyl, and while the ruling quotation is about \$3 per gal. for 190 proof, spot goods are moving at a considerably higher figure. *Denatured*, not so scarce as the others, is quoted slightly higher than in the past, \$1.05 being today's quotation. *Formaldehyde* is in no better supply, and the price remains constant at about 65c. per lb. Manufacturers are pretty well sold up on future production capacity and are becoming reluctant to make new contracts.

A more insistent demand is felt for alkali products than for any other line. Raw materials are hard to get, containers are scarce, and the goods themselves are hard to move after production and packing is completed. *Bleaching powder* continues to rise in price, with present quotation 4@5c. per lb., f.o.b. cars at factory. *Soda ash* is in very light supply and most manufacturers report their product sold up for the remainder of the year. Nominal quotation remains at 4½c. per lb., with spots bringing as high as 5c. This week's transactions in *caustic soda* have ranged from 6¾c. to 7c. per lb., and contracts for future business are being placed at 7c. per lb. in cars f.o.b. works. Conditions on *salsoda* are unchanged, ruling price being \$1.35 per cwt. f.o.b. factory and \$1.60 per cwt. out of Chicago stock.

The *glycerine* market continues very strong, quotation on c.p. grade being 26c. per lb. Purchases of this commodity in the past few weeks have been so heavy as apparently to assure a figure at least this high for some time to come. *Aqua ammonia*, reported last week as selling at 10c. out of stock, has lately been run up as high as 11c. This is wholly on account of the difficulty of obtaining material, as manufacturers are still quoting 8¼@8½c. per lb. on contracts. The last quotation of 16c. per lb. for white granulated *salammoniac* holds good, but deliveries at that or any other figure are hard to get. Demand is very light, consumers recognizing the difficulty of procuring shipment. Liquid *chlorine* remains very firm and manufacturers show no anxiety to close contracts at the prevailing figure of 8@8½c. per lb. *Sodium nitrite* seems to be in better supply, with the price unchanged at 26c. per lb. Actual transactions in all of these commodities are very light.

The scant movement of acids, particularly *sulphuric*, is causing stagnation in many lines of the chemical industry. Prices show much more strength than they have for some time past, but the market has not been stampeded by the present conditions which are recognized to be only temporary. *Sulphuric* acid, 66 deg., is quoted for early delivery at \$24 per ton and for immediate delivery, that is, as soon as shipment is possible, at \$25 per ton. Increases in the price of raw material have affected *acetic* acid, increasing the current quotation on 28 per cent to \$3.75 per cwt., and on 56 per cent to \$8.40 @ \$8.50 per cwt. Almost no actual transactions are taking place in *muriatic* acid, on which quotation is 34c. per lb. for 22 deg. *Nitric* has recovered from past depression and is now quoted at 7½c. per lb. for 42 deg., and *oxalic*, with almost no supply visible, is tightly held at 56c. per lb.

Coal-Tar Products

The coal-tar product market seems to be the most seriously affected of all chemical lines by the present strike situation. Recovery had not been complete from the derangement occasioned by the coal and steel strikes when the present trouble started, and the situation today seems more serious, so far as production is concerned, than ever before. Supplies of crudes are on a hand-to-mouth basis and prices at which goods are actually changing hands vary widely. *Benzol* is bringing about 30c. per gal. for spots with no change recorded on prices of contract orders. Makers have practically no supply of *solvent naphtha* on hand and what few current transactions are being recorded are at about 32c. Small supplies of *naphthaline* are available, current prices being, for balls 18c. per lb.; flakes, 17c. per lb. *Toluol* is also difficult to get and current price ranges from 29c. to 31c. per gal. No price changes of moment are recorded in coal-tar acids, the quotation on *benzoic* being 75c. per gal. for technical and 90c. per gal. for c.p. *Salicylic* is quoted at 50c. per gal. for technical, and 55c. per gal for c.p. The supply of intermediates is so short as to render any quotations impossible. *Aniline oil* and *aniline salts* both remain in heavy demand, with prices ranging from 40c. upward on the oil and from 50c. upward on the salts.

Vegetable Oils

The condition noted last week of no supplies and likewise no buyers continues in effect. Local price on *linseed oil* in barrels remains unchanged at \$2.05 per gal., but the carload price has fallen off somewhat. This quotation ranges from \$1.65 to \$1.70 per gal. Demand is very light.

Prices are weak on all the other oils. *Soya bean* is quoted in sellers' tanks, f.o.b. Coast, at 13½c. per gal. and in barrels, f.o.b. Chicago, at 18½c. Crude *cottonseed oil* under light demand is a shade off to 16c. Prime summer yellow remains firm at 18c. and refined deodorized in barrels still brings 22½c. *Cocoanut oil* is down a little to a present quotation in sellers' tanks, f.o.b. Coast, of about 16½c. No market seems to exist on corn oil, the nominal quotation for prime grade in tanks being 15¾ @ 16c. per lb.

Flotation Oils—Naval Stores

Present price on turpentine should probably be about \$2.30 per gal. To this, on local sales, is being added the cost of trucking from various railroad points from ten to thirty miles from Chicago. This has caused the current figure for turpentine in barrels to be placed at \$2.56 per gal. Reacting to a feeling that the transportation difficulties were going to be shortlived, on May 3 the price was dropped from the previous quotation of \$2.57 per gal. to \$2.25 per gal. The resulting renewal of buying and the prolongation of the rail trouble forced the price back to the present figure in one week. *Pine oil* remains high, *.933 pure steam distilled* now standing at \$1.80 per gal. and *pure destructively distilled* at \$1.70 per gal., these prices being for barrels. *Pine-tar oil* holds the previously quoted price of 42c. To a great extent these prices are nominal, there being practically no supply.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.65 - $0.75
Acetone	lb.	$0.19 - $0.20	.21 - .22
Acid, acetic, 28 per cent	cwt.	3.50 - 3.75	4.00 - 4.25
Acetic, 56 per cent	cwt.	6.50 - 7.00	8.75 - 9.00
Acetic, glacial, 99½ per cent, carboy	cwt.	15.50 - 16.00	16.50 - 17.50
Boric, crystals	lb.	.14½ - .15½	.15½ - .16½
Boric, powder	lb.	.14½ - .15	.15 - .16
Citric	lb.	.85 - .86	1.17 - 1.18
Hydrochloric (nominal)	cwt.	3.00 - 3.25	3.50 - 4.00
Hydrofluoric, 52 per cent	lb.	.12 - .12½	.13 - .14
Lactic, 44 per cent tech	lb.	.11 - .11½	.12 - .16
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.06 - .07	.07½ - .08½
Nitric, 42 deg	lb.	.07½ - .08	.08½ - .09½
Oxalic, crystals	lb.	.55 - .57	.58 - .59
Phosphoric, Ortho, 50 per cent solution	lb.	.22 - .23	.24 - .25
Picric	lb.	.30 - .35	.40 - .50
Pyrogallic, resublimed	lb.	2.50 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 - 18.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	21.00 - 25.00	–
Sulphuric, 66 deg., drums	ton	35.00 - 40.00	–
Sulphuric, 66 deg., carboys	ton	36.00 - 40.00	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 - 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 - 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 –
Tannic, U. S. P.	lb.	1.50 - 1.60	1.65 - 1.70
Tannic (tech.)	lb.	–	.60 - .90
Tartaric, crystals	lb.	–	.75 - .80
Tungstic, per lb. of WO	lb.	–	1.20 - 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl (nominal)	gal.	2.50 - 3.50	–
Alcohol, denatured, 188 proof (nominal)	gal.	–	1.00 - 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	–	.98 - 1.02
Alum, ammonia lump	lb.	.04½ - .05	.05½ - .06
Alum, potash lump	lb.	.07½ - .08¼	.09 - .09½
Alum, chrome lump	lb.	.17 - .18	.19 - .20
Aluminum sulphate, commercial (nominal)	lb.	.01½ - .02	.02½ - .03½
Aluminum sulphate, iron free	lb.	.02½ - .03	.03½ - .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ - .10½	.11 - .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 - .35	.35 - .40
Ammonium carbonate, powder	lb.	.16 - .16½	.17 - .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 - .16½	.17 - .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 - .13½	.14 - .14½
Ammonium nitrate	lb.	.08½ - .12	–
Ammonium sulphate	lb.	.07 - .08	.08½ –
Amylacetate	gal.	–	3.65 - 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.13½ - .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 - .24	–
Barium chloride (nominal)	ton	150.00 - 160.00	165.00 - 175.00
Barium dioxide (peroxide)	lb.	.21 - .23	.24 - .25
Barium nitrate	lb.	.10 - .11	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.85 - .90	1.00 - 1.05
Calcium acetate	cwt.	3.50 - 3.55	–
Calcium carbide	lb.	.04½ - .04¾	.04¾ - .05½
Calcium chloride, fused, lump	ton	23.00 - 25.00	30.00 - 40.00
Calcium chloride, granulated	lb.	.01½ - .01¾	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 - 4.25	4.35 - 5.00
Calcium peroxide	lb.	–	1.50 - 1.70
Calcium phosphate, monobasic	lb.	–	.75 - .80
Calcium sulphate, pure	lb.	–	.25 - .30
Carbon bisulphide	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums	lb.	.11 - .11½	.12 - .15½
Carbonyl chloride (phosgene)	lb.	–	.80 - 1.05
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	.30 - .35	.36 - .38
Cobalt oxide	lb.	–	2.00 - 2.05
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 - .28	.29 - .31
Copper cyanide	lb.	–	.65 - .70
Copper sulphate, crystals	lb.	.08½ - .09	.09 - .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent (nominal)	lb.	.38 - .40	.60 - .80
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.24½ - .26
Iodine, resublimed	lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red	lb.	–	.03 - .20
Iron sulphate (copperas)	cwt.	1.50 - 1.75	1.80 - 2.00
Lead acetate, normal	lb.	.14 - .14½	.15 - .18
Lead arsenate (paste)	lb.	.11 - .12	.13 - .17
Lead nitrate, crystals	lb.	–	.90 - 1.00
Litharge	lb.	.14 - .15	.15½ - .16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.12 - .14	.15 - .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 - 3.55	3.60 - 4.25
Magnesium sulphate, commercial	100 lb.	–	3.25 - 3.60
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 - .17	.17½ –
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 - .55	.60 - .65
Phosphorus, yellow	lb.	–	.35 - .37
Potassium bichromate	lb.	.36 - .37	.40 - .46
Potassium bitartrate (cream of Tartar)	lb.	.53 - .56	.57 - .58
Potassium bromide, granular	lb.	.80 - .85	.90 - .95
Potassium carbonate, U. S. P.	lb.	–	.85 - .88
Potassium carbonate, crude	lb.	.21 - .25	.26 - .28
Potassium chlorate, crystals	lb.	.14 - .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 - .29	.30 - .38
Potassium iodide	lb.	–	3.35 - 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	.65 - .95
Potassium prussiate, red	lb.	$0.90 - $1.00	$1.05 –
Potassium prussiate, yellow	lb.	.32 - .36	.38 - $0.41
Potassium sulphate (powdered)	ton	$225.00 - 240.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	28.00 - 32.00	–
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.74 - .76
Soda ash, light	100 lb.	–	3.50 - 3.60
Soda ash, dense	100 lb.	–	3.55 - 3.65
Sodium acetate	lb.	.08½ - .09	.09½ - .10
Sodium bicarbonate	100 lb.	2.25 - 2.60	2.75 - 3.00
Sodium bichromate	lb.	.39 - .41	.42 - .43
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 10.00
Sodium bisulphite Powered	lb.	.06 - .06½	.07 - .07½
Sodium borate (borax)	lb.	.09 - .10	.10½ –
Sodium carbonate (sal soda)	100 lb.	1.60 - 1.80	1.80 - 2.00
Sodium chlorate	lb.	–	.12 - .14
Sodium cyanide, 96-98 per cent	lb.	.24 - .25	.26 - .27
Sodium fluoride	lb.	.18 –	.19 - .20
Sodium hydroxide (caustic soda)	100 lb.	5.00 - 6.00	7.00 - 7.50
Sodium hyposulphite	lb.	–	.03 - .04
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite	lb.	.22 - .24	.24 - .25
Sodium peroxide, powdered	lb.	.32 - .35	.35 - .40
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts)	lb.	.39 - .40	.40 - .41
Sodium prussiate, yellow	lb.	.23 - .2	.30 - .40
Sodium silicate, solution (40 deg.)	lb.	.01½ - .02	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.04 - .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.50 - 1.70	1.75 - 2.05
Sodiumsulphide, crystal, 60-62 per cent (conc)	lb.	.09 - .10	.10½ - .11
Sodium sulphite, crystals	lb.	.03½ –	.04 - .06
Strontium nitrate, crystals	lb.	.23 - .24	.25 - .26
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 - 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 - .50
Tin oxide	lb.	.60 - .63	.65 –
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran	lb.	.13 –	.13½ - .17
Zinc cyanide	lb.	.49 –	.50 - .60
Zinc dust	lb.	.12¼ - .12½	.13 - .15
Zinc oxide, U. S. P.	lb.	.18 - .19	.20 - .21
Zinc sulphate	lb.	.03½ - .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.05	$1.15
Alpha naphthol, refined	lb.	1.40	1.60
Alpha naphthylamine	lb.	.65	.70
Aniline oil, drums extra	lb.	.34	.45
Aniline salts	lb.	.46	.50
Anthracine, 80% in drums (100 lb.)	lb.	.90	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	2.10
Benzidine, base	lb.	1.35	1.40
Benzidine, sulphate	lb.	1.20	1.25
Benzoic acid, U.S.P.	lb.	.90	1.10
Benzoate of soda, U.S.P.	lb.	.80	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27	.36
Benzol, 90%, in drums (100 lb.)	gal.	.25	.31
Benzyl chloride, 95-97%, refined	lb.	.35	.40
Benzyl chloride, tech	lb.	.25	.35
Beta naphthol benzoate (nominal)	lb.	.50	.65
Beta naphthol, sublimed (nominal)	lb.	.70	.90
Beta naphthol, tech (nominal)	lb.	.45	.55
Beta naphthylamine, sublimed	lb.	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10	1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65	.75
Dichlorbenzol	lb.	.08	.10
Diethylaniline	lb.	1.40	1.50
Dimethylaniline (nominal)	lb.	....	1.80
Dinitrobenzol	lb.	.30	.37
Dinitroclorbenzol	lb.	.30	.35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	.40	.45
Dinitrotoluol	lb.	.40	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	.40
Diphenylamine (nominal)	lb.	.55	.65
H-acid (nominal)	lb.	2.25	2.50
Metaphenylenediamine	lb.	1.15	1.80
Monochlorbenzol	lb.	.12	.15
Monoethylaniline	lb.	1.70	1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.15	
Naphthaline, flake	lb.	.15	.17
Naphthaline, balls	lb.	.16	.18
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.20	.30
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	1.25
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.35	.45
Para-amidophenol, base	lb.	2.50	3.50
Para-amidophenol, HCl	lb.	2.50	3.25
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1.75	1.85
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.60	3.00
Paratoluidine	lb.	2.00	2.50
Phthalic anhydride	lb.	.65	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.25
Pyridin	gal.	2.00	2.50
Resorcin, technical	lb.	4.25	4.50
Resorcin, pure	lb.	6.25	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50	.52
Salicylic acid, U. S. P.	lb.	.55	.60
Salol	lb.	.90	1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.25	—	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.28	—	.32
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.22	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.40	—	.41
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1 (nominal)	lb.	.80	—	.88
Carnauba, No. 2, regular (nominal)	lb.	.60	—	.70
Carnauba, No. 3, North Country (nominal)	lb.	.45	—	.46
Japan	lb.	.21	—	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.....	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.....	—	.09¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.....	—	.11¼
Paraffine waxes, refined, 128-130 m.p.	lb.	.....	—	.13½
Paraffine waxes, refined, 133-135 m.p.	lb.	.14	—	.15
Paraffine waxes, refined, 135-137 m.p.	lb.	.16	—	.16½
Stearic acid, single pressed	lb.	.26	—	.27
Stearic acid, double pressed	lb.	.32	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

*Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

*(See New York market letter)

*Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$16.95	—	$18.75
Rosin E-I	280 lb.	18.75	—	19.00
Rosin K-N	280 lb.	19.00	—	21.00
Rosin W. G.-W. W	280 lb.	20.50	—	21.50
Wood rosin, bbl.	280 lb.	15.50	—	18.50
Spirits of turpentine	gal.	.....	—	2.45
Wood turpentine, steam dist.	gal.	2.35	—	2.40
Wood turpentine, dest. dist.	gal.	.....	—	2.00
Pine tar pitch, bbl.	200 lb.	8.40	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb	15.00	—	15.50
Rosin oil, first run	gal.	.92	—	.95
Rosin oil, second run	gal.	.94	—	.97
Rosin oil, third run	gal.	1.00	—	1.05
Rosin oil, fourth run	gal.	1.10	—	1.15

* (See New York market letter)

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31¼
68-70 deg., steel bbls. (85 lb.)	gal.	.30¾
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½	—	$0.42
Upriver coarse	lb.	.29	—	.32
Upriver caucho ball	lb.	.30½	—	.33
Plantation—First latex crepe	lb.	.44	—	.45
Ribbed smoked sheets	lb.	.44½	—	....
Brown crepe, thin, clean	lb.	.42	—	....
Amber crepe No. 1	lb.	.40½	—	.41½

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.23
China wood oil, in bbls.	lb.	.22	—	.23
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½	—	.18¾
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.19	—	.19½
Corn oil, crude, in bbls.	lb.	.17½	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15¾	—	.16
Cottonseed oil, summer yellow	lb.	.19½	—	.20
Cottonseed oil, winter yellow	lb.	.21	—	.22
Linseed oil, raw, car lots	gal.	1.72	—	.....
Linseed oil, raw, tank cars	gal.	1.67	—	.....
Linseed oil, boiled, car lots	gal.	1.75	—	.....
Olive oil, commercial	gal.	2.75	—	3.00
Palm, Lagos	lb.	.13½	—	.14½
Palm, bright red	lb.	.14½	—	.17½
Palm, Niger	lb.	.12¾	—	.14
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.19	—	.20
Peanut oil, refined, in bbls.	lb.	.24	—	.25
Rapeseed oil, refined in bbls.	gal.	1.70	—	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80	—	1.82
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.13¾	—	.14

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.34	—	1.36

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Barytes, crude	ton	10.00	—	12.00
Blanc fixe, dry	lb.	.05½	—	.06½
Blanc fixe, pulp	ton	60.00	—	80.00
Casein	lb.	.15	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50	—	18.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite, crucible, 85% carbon content	lb.	......	—	.07½
Graphite, crucible, 86% carbon content	lb.	......	—	.08
Graphite, crucible, 87% carbon content	lb.	......	—	.08½
Graphite, crucible, 88% carbon content	lb.	......	—	.09
Graphite, crucible, 89% carbon content	lb.	......	—	.09½
Graphite, crucible, 90% carbon content	lb.	......	—	.10
Graphite, crucible, 91% carbon content	lb.	......	—	.10½
Graphite, crucible, 92% carbon content	lb.	......	—	.11
Graphite, crucible, plus 92%	lb.	......	—	.12½
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	....
Shellac, orange, fine ... nominal	lb.	1.50	—	
Shellac, orange, superfine	lb.	1.60	—	1.65
Shellac, A. C. garnet	lb.	1.30	—	1.35
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	30.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	$75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn	gross ton	200.00	—	250.00
Spiegeleisen, 16-20% Mn	gross ton	73.00	—	75.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	200.00
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	—	1.10
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, C_2O_3 f.o.b. Atlantic Seaboard	unit	$0.70	—	$0.85
Chrome ore, 48% and over †	unit	.....	—	.....
Coke, foundry, f.o.b. ovens	net ton	12.00	—	14.00
Coke, furnace, f.o.b. ovens	net ton	11.00	—	12.00
Petroleum coke, refinery, Atlantic seaboard	net ton	.....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00	—	30.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00	—	65.00
Manganese ore, 45% Mn and over	unit	.80	—	.95
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	7.50
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore	lb.	1.00	—	3.00
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

*Nominal †See New York Market Letter

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45@ $4.00
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45@ 4.00
Tees, 3-in. and larger	100 lb.	2.45@ 4.00
Plates	100 lb.	2.65@ 4.00
Rivets, structural, ¾-in. and larger	100 lb.	4.50
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.60
Sheets, No. 28 black	100 lb.	4.35@ 6.50
Sheets, No. 10 blue annealed	100 lb.	3.55@ 6.00
Sheets, No. 28 galvanized	100 lb.	5.70@ 8.50

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

HAMDEN—The Mt. Carmel Brass Fdry. Wks., Mt. Carmel, has awarded the contract for the construction of a 1-story, 25x115-ft. foundry at Mt. Carmel, to the Sperry Eng. Co., 82 Church St., New Haven. Estimated cost, $20,000.

MANSFIELD DEPOT — The Mansfield State Training School will soon award the contract for the construction of a 1-story, 40x50-ft. filter plant and a concrete dam. Estimated cost, $25,000. Ford, Buck & Sheldon, Inc., 60 Prospect St., Hartford, engrs.

NEW HAVEN—The Fritzell Brass Fdry. Co., 33 Chestnut St., plans to build a 1-story, 60x150-ft. plant addition on Chestnut St. Estimated cost, $40,000. Fletcher, Thompson, Inc., 1089 Broad St., archts. and engrs.

WATERVILLE (Waterbury P. O.)—The Amer. Pin Co., Thomaston Ave., has awarded the contract for the construction of a 2-story, 40x101-ft. factory addition for the manufacture of brass goods, to the Torrington Bldg. Co., 197 Water St. Estimated cost, $35,000.

District of Columbia

WASHINGTON—The Dupont Fibre Silk Co., Dupont Bldg., Wilmington, Del., is having plans prepared for the construction of a 3-story factory here. Estimated cost, $750,000.

WASHINGTON—The General Purchasing Officer of the Panama Canal will receive bids until May 25 for furnishing 60,000 lb. of sodium nitrate dynamite, 45% nitroglycerin and 50,000 lb. of sodium nitrate dynamite, 60% nitroglycerin.

WASHINGTON — The Washington Gas & Light Co., 411 10th St., has purchased Analostan Island and plans to construct a gas plant on same. Estimated cost, from $2,000,000 to $3,000,000. J. S. McIlheny, chief engr.

Illinois

CHICAGO—The Illinois Malleable Iron Co., 1801 Diversity Bldg., is having plans prepared for the construction of a 1-story plant. Cahill & Douglas, 217 Water St., Milwaukee, engrs.

CHICAGO—The Charles McAdam Co., 3167 Cottage Grove Ave., will soon award the contract for the construction of a 1-story, 65x250-ft. factory for the manufacture of painters' supplies, on West 27th and Troy Sts. Estimated cost, $100,000. J. C. Llewellyn, 38 South Dearborn St., archt.

CHICAGO—The Ward Baking Co., 2608 Lexington Ave., plans to build a bakery at Irving Park Blvd. and Kilbourne Ave.

CHICAGO—The Western Felt Wks. plans to build extensions to its plant at 4115 Ogden Ave.

Iowa

ALBIA—The city has awarded the contract for the construction of a sewage disposal plant to A. Phelps & Son, Knoxville, at $36,828. C. Atchison, clk.

AMES—The city will receive bids until June 7 for the construction of a sewage disposal plant, consisting of pumping plant, Imhoff tank, sludge bed and trickling filters, etc. Noted March 10.

WELLSBURG—The town has awarded the contract for the construction of a sewage disposal plant, to Ward & Weighton, 516-17 Davidson Bldg., Sioux City, at $16,700.

Kentucky

BOWLING GREEN—The Amer. Producing & Refining Co. is in the market for machinery for an oil refinery.

LOUISVILLE — Avery & Sons have awarded the contract for the construction of a 2-story, 120x175-ft. paint shop and a 5-story shipping warehouse in connection with the number of proposed additions to the present plant, to the Natl. Concrete Constr. Co., Bd. Tr. Bldg. Estimated cost, $400,000.

Massachusetts

CAMBRIDGE—Henry Thayer & Co., 150 B'way, will build a 3-story, 40x80-ft. plant addition for the manufacture of chemicals. Estimated cost, $30,000. Work will be done by day labor.

EAST WALPOLE—Bird & Son, Inc., has awarded the contract for the construction of a 1-story, 30x310-ft. building for the manufacture of roofing and floor coverings on Water St., to A. A. Appleby, 449 Washington St., Norwood. Estimated cost, $40,000. Charlie T. Main, 201 Devonshire St., engr.

SOUTH BOSTON (Boston P. O.)—The Joseph Burnett Co., 36 India St., Boston, has awarded the contract for the construction of a 7-story, 80x160-ft. manufacturing plant on Fargo and D Sts., to the W. M. Bailey Co., 88 Broad St., Boston. Estimated cost, $400,000.

SPRINGFIELD—B. E. Geckler, archt., 335 St. James Ave., will soon award the contract for the construction of a 1-story, 55x65-ft. foundry addition on Birnie Ave., for the Brightwood Brass & Bronze Fdry., Birnie Ave. Estimated cost, $20,000.

WILLIMANSETT (Holyoke P. O.)—The Stevens Duryea Co., Chicopee Falls, has awarded the contract for the construction of three manufacturing buildings including a 1-story, 60x270-ft. heat treating building, to P. J. Kennedy Co., Inc., 464 Maple St., Holyoke. Estimated cost, $800,000.

WOLLASTON (Boston P. O.) — The Howard Chemical Co., c/o E. R. Simpson, engr., 176 Federal St., Boston, has awarded the contract for the construction of a 3-story, 55x120-ft. factory for the manufacture of chemicals, etc. on Old Colony Ave., to S. C. Sperry Co., 300 Main St., Cambridge. Estimated cost, $50,000. Noted April 21.

Michigan

DETROIT—A. J. Detlaff, East Lafayette Ave., has awarded the contract for the construction of a 1-story, 51x88-ft. foundry on Lafayette and Hastings Sts., to Otto Misch Co., Chamber of Commerce. Equipment for making and handling malleable castings will be installed in same. Estimated cost, $10,000. Noted May 4.

HOUGHTON—The Michigan College of Mines, College Ave., is having plans prepared for the construction of a 2-story chemical building. Two complete chemical laboratories will be installed in same. Estimated cost, $100,000. Herbst & Kuenzli, Caswell Block, Milwaukee, Wis., archts.

Minnesota

JORDAN—The Bd. Educ. will soon award the contract for the construction of a 3-story, 67x112-ft. high and grade school. A chemical laboratory will be installed in same. P. T. Hunziker, clk. K. T. Snyder, 739 Plymouth Bldg., Minneapolis, archt.

REXVILLE—The Bd. Educ. will receive bids until May 30 for the construction of an 80x240-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $300,000. Croft & Boerner, Palace Bldg., Minneapolis, archts. Noted April 14.

SPRING GROVE—The Bd. Educ. is having plans prepared for the construction of a 2-story, 40x90-ft. school. A chemical laboratory will be installed in same. Sund & Dunham, 312 Essex Bldg., Minneapolis, archts.

WAYZATA — The Bd. Educ. is having plans prepared for the construction of a 3-story, 136x148-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, $150,000. Hewitt & Brown, 716 4th Ave. S., and Tyrie & Chapman, 320 Auditorium Bldg., Minneapolis, archts.

Missouri

KANSAS CITY—The Corn Products Refining Co., 17 Battery Pl., New York City, plans to build a 1-story factory. Estimated cost, $7,000,000.

New Hampshire

HANOVER — Dartmouth College has awarded the contract for the construction of a 4-story, 60x150-ft. chemical laboratory, to the Cummings Constr. Co., Woodsville. Estimated cost, $264,000.

New Jersey

HADDONFIELD — The city, Borough Hall, has awarded the contract for the construction of a sewage disposal plant, to William Penn Corson, Camden, at $12,799. Noted April 21.

JERSEY CITY — The Amer. Butterine Co., Henderson St., has awarded the contract for the construction of a 5-story, 50x100-ft. factory to the Realty Associates, 162 Remsen St., Brooklyn.

NEWARK—J. Campbell & Co., 75 Hudson St., New York City, has awarded the contract for the construction of a 1-story, 91x223-ft. dye building and power house on Plum Point Lane, to J. Jewks & Sons, 676 Montgomery St., Jersey City.

TRENTON — The McFarland Fdry. & Machine Co., Mead St., plans to construct a large plant including a 1-story, 50x120-ft. foundry. Estimated cost, $23,000. N. A. K. Bugbee Co., 206 East Hanover St., engr.

TRENTON—The Trent Tile Co., Klagg Ave., has awarded the contract for the construction of a 1-story, 50x100-ft. addition to its plant, to J. W. Thompson, Broad St. Bank. Estimated cost, $12,000.

VINELAND—F. H. Bent, engr., 142 W. State St., Trenton, will receive bids for the construction of a sewerage system, including a septic tank, etc., at the Home for the Feeble Minded, here. Estimated cost, $15,000.

New York

BEAVER FALLS—The J. P. Lewis Co., paper manufacturers, will rebuild two buildings which were recently destroyed by fire, entailing a loss of $100,000.

NIAGARA FALLS—The Electric Smelting & Aluminum Co., Mill Track 9, plans to build a hollow tile factory addition on West Jackson St. Estimated cost, $10,000.

PYRITES—The De Grasse Paper Co. has awarded the contract for the construction of a 1-story, 60x208-ft. machine room addition to its present plant here, to Hodge & Foster, Flower Bldg., Watertown, at $100,000. Noted April 14.

North Carolina

GASTONIA — Glass & Authur has awarded the contract for the construction of a 1-story, 50x75-ft. foundry, to James McAllister. Estimated cost, $5,000.

NAVASSA—The Morris Fertilizer Co., Citizen and Southern Bank Bldg., Atlanta, Ga., has awarded the contract for the construction of a fertilizer factory, to A. Bentley & Sons, Jacksonville, Fla.

North Dakota

GRAND FORKS—The Industrial Comn. of North Dakota, Bismarck, will receive bids until May 29 for the construction of a reservoir and filter plant. C. L. Pillsbury Co., 2305 Oliver Ave. S., Minneapolis, Minn., engr.

Ohio

ASHLAND—The Alboy Co. will soon award the contract for the construction of a 2-story, 200x200-ft. factory for metal stamping. Estimated cost, $150,000. Dercum & Beer, 4500 Euclid Ave., Cleveland, archts.

CLEVELAND—The Holan Mfg. Co., 3809 Clark Ave., has awarded the contract for the construction of a 1-story, 43x104-ft. drying kiln and a 41x100-ft. mill at 5600 Parkbrook Rd., to F. J. Jirka, 4216 Warren St. Estimated cost, $100,000.

DELAWARE—The Delaware Water Co. plans to build a 2-story filter plant.

WOOSTER—The Akron Brass Mfg. Co. has awarded the contract for the construction of a 1-story, 50x185-ft. foundry and machine shop, to J. S. Smythe, Wooster. Estimated cost, $20,000.

Pennsylvania

PHILADELPHIA — The Atlantic Refining Co., 1211 Chestnut St., plans to construct an oil manufacturing plant addition on Snyder Ave., west of 29th St.

WASHINGTON—The Hazel Atlas Glass Co. is building a 1- and 2-story, 100x368-ft. glass factory at its plant here. Estimated cost, $500,000.

Rhode Island

CENTRAL FALLS (Pawtucket P. O.)—The United Nets Corp., 229 4th Ave., New York City, has awarded the contract for the construction of a dyehouse and bleachery on High St., to the Central Const. Co., Pawtucket. Estimated cost, $20,000. Noted May 4.

South Carolina

BENNETTSVILLE—The Mailboro Fertilizer Co. plans to build an 80x200-ft. fertilizer factory.

CAYCE—The Seminole Fertilizer & Oil Co., Jacksonville, Fla., plans to build a fertilizer plant.

CHESTER—The Baldwin Cotton Mills has awarded the contract for the construction of a sewage disposal plant to Tucker & Horton, Charlotte, N. C.

Virginia

RICHMOND—The Standard Paper Mfg. Co., Hull and Canal Sts., is building a factory for the manufacture of blotting paper. Estimated cost, $150,000. J. H. Wallace & Co., 5 Beekman St., New York City, archt. and engr.

Wisconsin

HORICON—The Columbus Canning Co., c/o C. L. Davidson, supt., has awarded the contract for the construction of a 2-story, 96x108-ft. canning factory on Main St., to F. J. Pluckhahn, Juneau. Estimated cost, $40,000.

MILWAUKEE—H. A. Poppert Mfg. Co., 505 Cedar St., has awarded the contract for the construction of a 26x52-ft. foundry on 5th St., to Byrne Bros., 2112 Burleigh St. Foundry equipment will be installed in same. Estimated cost, $5,000.

TOMAHAWK — The Pride Pulp and Paper Co. plans to build a paper mill. C. B. Pride, pres.

Wyoming

LARAMIE — The Standard Oil Co., Casper, is building a Burton Process pressure plant here. The plant will consist of principally ten 8x40-ft. pressure stills and necessary storage equipment and will handle distillates for the Midwest Refining Co.

Quebec

MONTREAL — The Congoleum Co. of Canada has awarded the contract for the construction of a 70x118-ft. building on St. Patricks St., to the Atlas Constr. Co., 37 Belmont St. Estimated cost, $105,000.

Ontario

PETERBORO—The city plans to build a sewage disposal station and pumping plant. Estimated cost, $50,000. R. H. Parsons, City Hall, engr.

PORT CREDIT—The village plans to construct a waterworks system. Plans include a chlorination system and the installation of mechanical filters, etc. Estimated cost, $80,000. E. A. James Co., Ltd., 36 Toronto St., Toronto, engr.

LONDON—The W. T. Rawleigh Co., 55-65 Liberty St., Freeport, Ill., will receive bids about June 1 for the construction of factory buildings for the manufacture of pure food products on Adelaide St. Estimated cost, $300,000.

NEWMARKET—The city will soon award the contract for the construction of a sewer and activated sludge plant. Estimated cost, $65,000. E. A. James Co., Ltd., Toronto St., Toronto, engrs. Noted Jan. 7.

SUDBURY—The High School Bd. will soon award the contract for the construction of a 3-story school. Chemical and physical laboratory equipment will be installed in same. Estimated cost, $200,000. P. J. O'Gorman, archt. Noted March 17.

Coming Meetings and Events

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold a regular meeting June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its twelfth semi-annual meeting as follows: June 28 and 29 will be spent in Montreal, June 30 in Ottawa, July 1 in Ontario, July 2 in Shawinigan Falls, July 3 in La Tuque, July 4 in Chicoutimi and July 5 in Quebec.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS will meet in St. Louis May 27 to 29.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA plans to hold its annual convention in the Auditorium Theater, Chicago, Ill., May 19, 20 and 21.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NEW JERSEY CHEMICAL SOCIETY will hold a regular meeting and ladies' day Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J.

THE SOCIETY OF CHEMICAL INDUSTRY, American Section, will hold a meeting, May 21, at the Chemists' Club.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

Industrial Notes

THE WILSON-MAEULEN CO., New York City, has appointed Harry Goldsen, a practical instrument man, who knows the company's electrical pyrometers thoroughly, both from the manufacturing and service sides, as its new representative in the Pittsburgh district. He will have charge of both sales and service in that territory.

THE CELITE PRODUCTS CO., New York City, announces the appointment of Lyle Stockton Abbott as head of the Eastern sales department. Mr. Abbott succeeds H. A. Mannshardt, resigned.

THE FOUNDATION CO., New York City, announces that Edwin J. Beugler has become associated with it as vice-president in charge of engineering. Announcement is also made of the appointment of Joseph H. O'Brien as chief engineer.

THE HARRISON SAFETY BOILER WORKS, which has been carried on for many years as a co-partnership by Joseph S. Lovering Wharton, William S. Hollowell and John C. Jones, has been incorporated under the laws of Pennsylvania, charter perpetual, as the H. S. B. W.-Cochrane Corp. with the following officers and board of directors: Joseph S. Lovering Wharton, president; John C. Jones, vice-president and general manager; William S. Hollowell, secretary and treasurer; Horace E. Sibson, general sales manager, and Alexander B. Wallen, general works manager. The corporation takes over, as of date Jan. 2, 1920, the entire business of the former firm, acquiring its assets and assuming its liabilities.

YORK, REGAN & BURKE has been organized as a partnership with headquarters at 1323 North Clark St., Chicago, Ill., for the purpose of general consulting work as architect and engineer, embracing concrete engineering, buildings, bridges, concrete steel structures, industrial plants and other civil engineering work.

THE ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, makes several announcements: First, the following new orders for Greaves-Etchells electric furnaces: Wayne Steel & Iron Co., Croghan, N. Y., 1-ton furnace; Stora Kopparbergs Bergslags Aktiebolaget, Domnarfvet, Sweden, one 20-ton for steel ingots; Soc. Métallurgique de la Loire, St. Etienne, France, two 10-ton for steel ingots; S. A. C. Electriques de Charleroi, Belgium, one ½-ton for castings; Carlisle Steel Co., Sheffield, one ½-ton for tool steel; Sproat Marley & Co., Newcastle, England, one 1-ton for steel castings. Second, the successful starting up of the Greaves-Etchells electric furnaces at the following companies: Dodge Steel Castings Co., Philadelphia; American Radiator Co., Buffalo, N. Y.; Hammond Steel Co., Syracuse, N. Y.; Charles Bertolus, Bellegarde, France; Fonderie Ambrogie Necchi, Milan, Italy. Third, the following appointments of agents and representatives for the Greaves-Etchells electric furnaces: H. M. Smith, 39 Schofield Bldg., Cleveland, Ohio; A. S. Lindstrom, 519 California St., San Francisco, Cal.; McCrum & Gillem, 1011 Empire Bldg., Birmingham, Ala.; D. P. Morisseau, General Welding & Supply Co., Wainwright Bldg., St. Louis, Mo.

Manufacturers' Catalogs

WILLIAM R. PERRIN & CO., Chicago, Ill., is issuing a new filter press circular.

LEEDS & NORTHRUP CO., Philadelphia, Pa., calls attention to a pamphlet, Catalog No. 90, entitled "The Hump Method for the Heat Treatment of Steel," which describes a radically new way of hardening steel. Accurate measurement of temperatures and the independent determination of transformation points are rendered unnecessary. The work is heated in an electric furnace in contact with, or near to, a thermocouple. A recording instrument draws upon a large scale chart a curve of the electromotive force developed by the thermocouple. While the work is passing through the transformation or decalescence point, the rise in temperature is arrested, producing a decided jog or "hump" in the line. The operator allows the work to remain in the furnace a definite number of minutes after this hump appears and then quenches. The results claimed are entire uniformity of heat treatment, including grain size, hardness and tensile strength, together with freedom from distortion, breakage, decarbonization and scale. In addition, there are certain advantages due to the use of electric furnaces, such as cleanliness, low upkeep charges, ability to locate the heat treating department in the machine shop where the material can be treated in the direct course of manufacture, thus reducing handling charges and bringing all operations under the supervision of one man. A number of large concerns are using this method for hardening tools and dies and for the quantity production of automobile gears, races for ball bearings, etc. The total cost of operation, including labor and electric current is said to be less than that of fuel-fired furnaces, where quantity rates for current can be obtained, while the quality of the product is improved and standardized.